BANANA BOARD RESEARCH DEPARTMENT

JAMAICA

ANNUAL REPORT

1957-1958

10 SOUTH AVENUE, KINGSTON GARDENS
KINGSTON, JAMAICA.

COMMONWEALTH MYCOLOGICAL INSTITUTE
10 NOV 1959

October, 1959

BANANA BOARD RESEARCH DEPARTMENT

"Fontabelle",
10 South Avenue,
Kingston Gardens,
Kingston, Jamaica, W.I.
28th May, 1959.

The Chairman,
Banana Board.

Dear Sir,

The Research Committee of the Banana Board have pleasure in submitting the second Annual Report of the Research Department covering 1st April, 1957 to 31st December, 1958. In future the Report will cover a full calendar year thus coinciding with the recently changed financial year of the Banana Board.

Yours faithfully,

(Sgd.) R. LEACH,
Chairman of the Banana Board Research Committee
& Director of Research.

ERRATA

Page 11, para. 10 - line 1 - for "1954" read "1955"
Page 12, para. 6 - line 2 - for "procedure" read "procedures"
" " " " - line 3 - for "was" read "were"
" " " " - line 3 - for "followed by" read "and"

BANANA BOARD RESEARCH DEPARTMENT
ANNUAL REPORT

1957/1958.

INDEX

I. INTRODUCTION .. .. p. 4

II. REPORT OF CROP PHYSIOLOGIST (E. A. TAI) .. p. 5
- A. Timing of Crop Production .. .. .. p. 5
- B. Openhandedness .. .. p. 6
  - (i) Measurement of openhandedness .. .. p. 6
  - (ii) Root pruning experiment .. .. p. 6
  - (iii) Effect of timing fertilizer applications .. p. 6
  - (iv) Source of suckers .. .. .. p. 7
- C. Premature Yellowing .. .. .. p. 7
  - (i) Injection studies .. .. .. p. 7
  - (ii) Nutrition studies .. .. .. p. 7
- D. Empirical Studies .. .. p. 7
  - (i) Time of planting .. .. .. p. 7
  - (ii) Tissue analyses .. .. .. p. 8

III. REPORT OF SOIL CHEMIST (C. G. JORDINE) .. p. 8
- A. Laboratory .. .. p. 8
- B. Comparative Investigation on one Estate .. .. p. 8
- C. Survey of Banana Fields and Soils .. .. p. 10
  - (i) Physical analyses .. .. .. p. 10
  - (ii) Chemical analyses .. .. .. p. 10
- D. Ad hoc Experiments .. .. p. 10

IV. REPORT OF ANALYST (MRS. D. BOLAND) .. .. p. 11
- A. Leaf Analysis .. .. p. 11
  - (i) Leaf sampling .. .. p. 11
    - (a) Reduction in size of leaf sample .. .. p. 11
    - (b) Leaf samples as an index of nutritional status p. 12
  - (ii) Spray removal .. .. p. 12
- B. Analysis of Fruit .. .. p. 12
  - (i) Tenderness of fruit in relation to potash content p. 12

V. REPORT OF AGRONOMIST (V. R. LUMSDEN) .. p. 12
- A. Fertilizer Trials .. .. p. 13
  - (i) Comparisons .. .. p. 13
    - (a) St. Catherine plains .. .. .. p. 13
    - (b) St. Mary .. .. p. 13
  - (ii) NPK trials .. .. p. 13
    - (a) 3^3 Factorial experiment in Portland .. p. 13
    - (b) 3^3 Factorial experiment in Christiana Area p. 14
    - (c) 3^3 Factorial experiment in St. Ann .. p. 14
    - (d) 3×2^2 Factorial experiments .. .. p. 14
- B. Defoliation Experiment — St. Catherine Plains .. p. 14
- C. Sucker Timing Observations .. .. .. p. 15
- D. Relationship between Height at Shooting, Average Girth and No. Hands at Different Sites .. .. p. 15

E. Relationship between Time from Shooting to Reaping and the Month of Shooting at Different Altitudes .. p. 16
F. Crop Timing Demonstrations .. .. .. p. 16

VI. REPORT OF PLANT PATHOLOGIST (R. LEACH) .. p. 16
A. Banana Leaf Spot .. .. p. 16
(i) Oil spraying experiments .. .. p. 16
(a) Comparisons between four new spray oils screened by one oil company .. .. p. 18
(b) Comparative trials between new spray oils marketed by three different oil companies .. p. 18
(ii) Mist-spraying experiments with water miscible fungicides .. .. p. 18
(a) Comparative trial with four copper fungicides p. 18
B. Borer Weevil (Cosmopolites sordidus) .. .. p. 19
(i) Borer survey .. .. p. 19
(ii) Borer control experiments .. .. p. 19
(a) Comparative insecticide trials .. .. p. 19
(b) Effect of borer on growth of banana plants .. p. 19
C. Blackhead Toppling Disease .. .. .. p. 20
(i) Population of nematodes in banana tissue .. p. 20
(ii) Treatment of planting material .. .. p. 20
(iii) Use of nematocides at time of planting .. p. 21
(iv) Nematocide treatment on established banana plants p. 21
(v) Banana varietal resistance to Radopholus similis p. 21
D. Speckle (Fruit Spot) .. .. p. 22
(i) Nitrogenous fertilizer experiment .. .. p. 22
(ii) Fruit bagging experiment .. .. p. 22
E. Fruit Storage Diseases

VII. REPORT OF ASSISTANT PLANT PATHOLOGIST (D. S. MEREDITH) .. .. p. 23
A. Fruit Rotting Fungi Associated with Wastage .. p. 23
(i) Anthracnose .. .. p. 23
(a) Symptoms of disease on Jamaican fruit .. p. 23
(b) Experimental infection .. .. p. 24
(c) Latent infection .. .. .. p. 24
(ii) Santa Marta Stem End Rot .. .. p. 25
(iii) Main-stalk Rot .. .. .. p. 26
(iv) A note on Trachysphaera fructigena on Jamaican bananas .. .. .. p. 27

VIII. REFERENCES .. .. p. 27

IX. PUBLICATIONS .. .. p. 28

APPENDIX .. .. p. 28

DIAGRAMS .. .. p. 42

ANNUAL REPORT — 1957/1958

I. INTRODUCTION

This report covers the period from April 1st, 1957, to December 31st, 1958, but in future the report will cover each calendar year coinciding with the altered financial year of the Banana Board.

Many of the Department's original research projects have now reached the stage when the results warrant publication. In order to avoid overburdening the text of the Annual Reports with innumerable Tables, these are in future to be included as an Appendix. Anyone wishing to examine the results of an experiment in detail can thus do so.

During the period under review, the banana industry experienced one of the worst droughts on record. This was confined largely to the important banana growing districts of St. Mary as well as parts of St. Ann and West Portland. Drought also occurred to a lesser extent in Hanover. The damage was so severe that bananas had to be cut back over extensive acreages, for which growers obtained financial relief from the industry.

The drought severely interfered with many of the Research Department's experiments, and in some cases these had to be abandoned for replanting. The policy of distributing experiments throughout the island and relying on the assistance of growers in providing land for field experimentation is working well up to a point, but a distressingly large number of experiments have had to be terminated due to unpredictable causes.

Various field studies of the Lacatan banana are yielding data which are helping to explain its irregular behaviour in regard to pruning and management of crop succession. The length of time that ratoon plants take to grow from "peepers" to shooting their bunches has been found at various altitudes to be considerably longer than was expected. This effect alone should convince growers of the desirability of attaining the maximum efficiency in assuring a succession of followers. Data concerning the shy suckering habit of Lacatan bananas have been obtained demonstrating the need to establish a principle of using "insurance" suckers to procure the best succession of ratoon bananas.

The results of several fertilizer experiments and sundry soil analyses suggest that potash fertilizers should be used to a much greater extent than they have been in the past. The uncertainty of soil analyses providing all the answers to the nutritional requirements of the banana plant has been well demonstrated in a case where bananas grown on alluvial soil have given good yields although analysis showed that the soil contained only 50 p.p.m. of K_2O.

The work of standardising and testing methods of foliage analyses has continued steadily. The results of this essential preliminary work are now starting to take shape and in the coming year the Physiology Division is likely to make a considerable advance towards establishing a method for undertaking analysis of banana foliage as a basis for routine advisory work.

Leaf spot control has received a severe setback in Jamaica owing to the increasing antipathy of growers to the use of low volume mist spraying with oil in certain parts of the island. This was due in the first instance to the conspicuous discolouration of foliage caused by the phytotoxic effect of the oil, especially in districts where bananas suffer from even the shortest droughts. This undesirable effect of oil has been associated recently with an even more striking manifestation of injury, namely, a widespread increase in "sheath splitting".

This weakening of pseudostems implies the existence of conditions which affect the metabolism of the banana plant. There is some indication that the effect is cumulative as this trouble has been on the increase. No experimental data have yet indicated any marked reduction in grade or fruit weight due to oil spraying but there are indications on certain estates that growers are experiencing this. In view of these latest developments, experiments have been started to compare the effect of oil spraying with low volume mechanical mist spraying using fungicides miscible in water.

Experiments in the use of Dieldrin have resulted in the All Island Banana Growers Association (A.I.B.G.A.) initiating the use of this insecticide in banana plantations, and the results are proving successful.

An increasing amount of importance is being attached to the loss of banana plants through blackhead toppling disease caused by the nematode, **Radopholus similis.** The general conclusion reached from all the preliminary nematode investigations is that **R. similis**

is causing such serious losses in the banana industry that a successful check to its activity should lead to a considerable improvement in the yield of bananas in Jamaica.

Speckle (or fruit spot) was particularly heavy in parts of the island in 1958, especially on the irrigated plains. This disease all too often is proving serious because of its adverse effect on the marketable value of the fruit in the U.K. The disease still seems to be considered physiological and there is some question whether oil spraying may render bananas more prone to it.

The Assistant Plant Pathologist joined the Department on September 1st, 1958, and was provided with laboratory and other facilities at Long Ashton Horticultural Research Station by kind permission of its Director, Professor H. G. H. Kearns, O.B.E. While there, he investigated the diseases of banana fruit arriving in the U.K. from Jamaica, both at Avonmouth and Southampton docks, and also studied their further development in various ripening rooms. It has been possible in this way to obtain detailed information about the condition of the fruit not only on arrival but also afterwards. Thus, for the first time, the Banana Board is in a position to understand fully the problems which must be overcome to improve the standard of Jamaican fruit on the U.K. market.

It is with gratitude that acknowledgment is here recorded of the help given to the Department by Mrs. L. M. Chuck of the Ministry of Agriculture, Messrs. R. F. Innes and T. Chinloy of the Sugar Manufacturers Association for their ever willing assistance with statistical problems. The growers, too numerous to mention here by name, have also continued to assist the research very greatly by their co-operation in providing facilities for field experiments, and to them the Department also extends its grateful thanks.

II. REPORT OF CROP PHYSIOLOGIST (E. A. TAI)

Much progress was made in the organization of the work of the Crop Physiology Section during the period under review. Erection of the office and laboratory building was completed in May, 1957, but it was some time before investigations in the laboratory could be actively undertaken as it required a period of three months to establish techniques and train junior staff in the operation of routines.

The Analyst, Mrs. S. F. Williams, resigned at the end of March, 1957, and her place was taken by Mrs. D. Boland who joined the Research Department on 1st July. Several changes took place among Technical Assistants and Clerical Staff so that at the end of December, 1958, there were five Technical Assistants and one Stenographer/Typist in the Section; two of the Technical Assistants work with the Soil Chemist and three with the Analyst.

The Crop Physiologist was absent from the island 1st to 8th December, 1957, when he represented the Director of Research at a meeting of the Banana Advisory Committee of the Regional Research Centre at the Imperial College of Tropical Agriculture in Trinidad. He took vacation leave in April, 1958, and attended the XVth International Horticutural Congress in Nice, 10th to 20th April as a representative of the Department; he presented a paper "Helicopter Spraying of Bananas against Sigatoka in Jamaica" on behalf of the Director. He resumed duties on 15th July and acted as head of the Department from 21st July to 9th November while the Director was away in the United Kingdom.

A plan for research evolved in 1956 was followed as closely as possible; routine fertilizer trials were handed over to the Agronomist, the survey of banana soils was commenced by the Soil Chemist who inspected and sampled a large number of fields in St. Mary in this connection and to the Analyst was entrusted most of the task of installing and checking apparatus and working out details of techniques to be employed for routine analyses; the Crop Physiologist continued studies on the behaviour in the field of bananas under different growing conditions and subjected to various management regimes.

Some advisory work was done directly for banana growers in a few instances but more often through the organization of the All Island Banana Growers Association. Advice was given chiefly on fertilizer requirements of different areas and suggested schedules, but also, in a number of cases on other aspects of field management of bananas.

The projects which received the direct attention of the Crop Physiologist may be grouped under — (a) Timing of Production, (b) Openhandedness, (c) Premature Yellowing and (d) Empirical Studies.

A. Timing of Crop Production

The two pruning trials laid down in 1956 were continued and use made of observations in the planning of 10 other experiments on potential methods of controlling the succession of Lacatan banana crops in different parts of the island. One trial was discontinued

after being severely damaged by flooding of the Rio Minho in January and again in May, 1958.

In both experiments there was considerable loss due to "blowdowns" even before shooting of the plants and several of those which shot failed to survive to reaping of the fruit. The effects of the pruning treatments on the plant crop were not strikingly different with respect to total suckers produced to each mat, time required to shoot or yield; in the first ratoons the shooting was extremely irregular where the first sucker had been chosen as follower, and shooting was later where the followers had been selected after the parents shot. (Appendix Phys. 1.).

Of the new trials six were commenced on plant bananas and the others on ratoons. Because of the limited availability of banana fields suitable for statistical layouts eight of the total were located on the plains of St. Catherine, Clarendon and St. Mary where the first crop is normally reaped at 12 months from planting, one was at medium low elevation quiring 15 months for the plant crop and the other at medium high elevation requiring approximately 18 months for the plant crop. By the end of 1958 two of the experiments had succumbed to changes in the local crop rotation schedules.

It was generally observed that growth of suckers depended largely on weather conditions and that normal production was obtained during the unusual droughts of 1957 and 1958 only in those plots which were given adequate irrigation. As a consequence strict adherence to the timing of followers prescribed by the planned experimental treatments was not always possible and plot population was maintained in several instances by retaining a relatively large number of "insurance" followers.

Experimental records were affected by losses due to blowdowns, and petty stealing of fruit; critical examination of yield data was not, therefore, always possible. Two periods of localised high winds in September and November 1957 uprooted a large percentage of the mats in the two St. Catherine experiments and rendered meaningless any measurements of time between the 1957 and 1958 crops obtained from bananas which had been planted in April and August 1956.

The time of selection of the follower did not appear to affect greatly the yield anywhere although there appeared to be a slightly shorter period between planting and shooting when suckers for the first ratoons were left between April and September on the plains and October to March in the hills. (Appendix Phys. 2.).

The experiments are being continued for observations on the ratoon crops; in the St. Mary and St. Thomas (un-irrigated) experiments the time at which the first ratoons shot after the shooting of the "plants' varied from 6.0 to 7.2 months. (Appendix Phys. 3.).

While definite conclusions cannot at present be drawn it may prove possible on the plains to harvest the plant and first ratoon crops, within the time of year when higher banana prices prevail, by manipulation of the planting date and setting of followers.

B. Openhandedness

Preliminary observations and field experiments covering openhandedness were concluded in 1958, routine estimation of the extent to which the condition occurs in other field trials has been continued, however. Some useful indications obtained from the early trials will serve as a basis for the planning of future trials.

(i) **Measurement of openhandedness:** Weekly assessments of openhandedness were made, on reaped fruit, at several points in the following districts — St. Catherine (17), Vere (4), St. Mary (13), Portland (9), St. James (3). These were considered with reference to relative management practices and local rainfall. Precise correlations could not be established but the evidence strongly suggests that openhandedness is highest under the following conditions — (1) In "plant" crops compared to ratoons; (2) Where fruit develops under conditions of water stress due to wind, drought or inadequate irrigation, resulting in shortness of finger length; (3) In areas of relatively high nitrogenous fertilization, due to wide spacing of the hands on the bunch stalk.

(ii) **Root pruning experiment:** The trial which commenced in February, 1956 was terminated in December, 1957. Complete records were not available on account of losses caused by blowdowns. They indicated, however, that root pruning at any stage effected a temporary slowing down of growth without influencing the incidence of openhandedness. (Appendix Phys. 4.).

(iii) **Effect of timing fertilizer applications:** The effect, on openhandedness, of varying the times of applying nitrogen fertilizers was investigated in a "plant" crop and the following ratoon crop. The individual experimental treatments proved impracticable in the

ratoon crop because of the great irregularity in sucker development. The measurements made indicated a likelihood of openhandedness being less where all the nitrogen fertilizing is done before shooting than where it is done at regularly spaced intervals throughout the life of the plant. (Appendix Phys. 5.).

(iv) **Source of suckers:** The trial in which observations were being made on the effects of sucker source on openhandedness of fruit produced was terminated before harvesting of the plant crop was completed; the area occupied by bananas was cleared for another crop. There was nothing to indicate that any influence might be exerted by source of the suckers.

C. Premature Yellowing

Three experiments were laid down in addition to those in progress at the time of the last report; two were brought to a premature end but the third has been continued. The original investigations were all concluded before the end of 1957.

(i) **Injection studies:** The observations at three sites in Portland, St. Thomas and St. James were concluded in May, 1957. No significant responses to the various injection treatments were obtained as regards occurrence of Premature Yellowing of the leaves in either plant or ratoon bananas. There appeared to be, however, a higher production of leaves in those plants which received 50 ml of a 0.2 M solution of potassium di-hydrogen phosphate than in others.

Injection of nutrients into banana plants has not proved easily practicable by the technique adopted and might only be justified by spectacular results. Continuation of work along this line has been deferred.

(ii) **Nutrition studies:** The exploratory trials conducted with NPK and so-called "minor element" mixtures, in St. Thomas and Westmoreland, were originally planned for observations over several ratoons but the bananas were grubbed in May, 1957. It was apparent that beneficial effects were obtained from application of mixtures containing P and K as compared with plants receiving the fertilizer treatment formerly accepted as standard for the areas. Iron (Ferro-Rexenol Granulate) and Magnesium (Kieserite or "Sporumix") applications also appeared to reduce the incidence of Premature Yellowing on the plots.

New experiments were designed to test the effects of varying the source of nitrogen and the frequency of potash applications on the incidence of Premature Yellowing. In Westmoreland the treatments were commenced in January, 1957, about 3 months from planting and the Premature Yellowing assessed in each plot at 2-month intervals from its first appearance in May until October when the field was bulldozed for planting sugar cane. At that time reaping of the plant crop was still in progress so complete yield data were not available.

An arbitrary scale for comparison of the extent of Premature Yellowing, on individual plants, was employed: 0 — (absence of the condition), 1 — (slight, under 20% leaf area affected), 2 — (medium, 20-40% leaf area affected), 3 — (heavy, over 40% leaf area affected), and the mean of the figures for the individual plants contained was taken as the measure for the various plots.

The results indicated very clearly that Premature Yellowing can be reduced by potash fertilizing and that nitrogen in the form of nitrate must be regarded as preferable to the other forms used in this experiment. It was also apparent that the condition became more noticeable on plots receiving nitrogen fertilizer than on the controls. (Appendix Phys. 6.).

Observations at Bog Walk were terminated when the area was cleared of bananas in January, 1958, but the St. Thomas experiment has been continued. Insufficient data were recorded at Bog Walk for reliable statistical analysis but interim results for St. Thomas were obtained. (Appendix Phys. 7.). In both areas it was apparent from visual inspection that less Premature Yellowing occurred in the plots receiving potash in 4 and 8 applications.

D. Empirical Studies

Observations aimed at securing information on growth and general behaviour of Lacatan bananas were continued in the field, and a series of analyses of various tissues commenced in the laboratory with the collaboration of the Analyst in an endeavour to evolve a technique for reliable evaluation of the nutrient status of plants.

(i) **Time of planting:** Dissections were made up to September, 1958, and it was found that differentiation of hands was nearly always discernible at approximately 5 months after planting. The time to "bulling" differed appreciably between plants set in the open and supplies and also for plantings in the different months. Average figures for the period up to bulling from actual planting time were, in months: "Plants" (8.9 $\pm$ 0.83), Supplies (9.5 $\pm$ 0.94), First Ratoons (15.2 $\pm$ 1.13). No pruning was done in the plot while observations were in progress.

The information relates to bananas in an area where the plant crop is normally reaped in 12 months from planting and it will be necessary to repeat the observations in other areas with longer "growing time".

(ii) **Tissue analyses:** In February, 1958, analyses were commenced on banana tissues from a field of vigorous, high-yielding Lacatan at Bodles Banana Breeding Station; it was arranged that samples should be taken monthly of leaves and roots from a number of plants so that comparisons would be possible between (1) leaves of similar age from different plants, (2) leaves of varying ages from individual plants, (3) roots of plants dug out completely, (4) roots collected in soil core samples. Determinations were made of nitrogen, phosphate, potash, calcium and magnesium.

A rough appraisal of the results obtained up to September, 1958, appeared to indicate that greatest consistency in contents of nitrogen and potash was shown by leaves between 16 and 25 days old borne on plants in their most vigorous vegetative stage, after the end of the sword stage and before "bulling". The general trend observed is for nitrogen content to rise to a peak in about the third fully expanded leaf while phosphate and potash contents fall with increased age of the leaves.

Since September, 1958, monthly collection of samples for analysis has been limited to the five youngest leaves on each four plants at three sites — two of good growth, high production and the third of poor growth and production. The speed at which the requisite analyses are made has been limited by laboratory space and it has not been possible to have analyses keep pace with sampling.

III. REPORT OF SOIL CHEMIST (C. G. JORDINE)

A. Laboratory

The Soil Chemist moved into the new laboratory in June, 1957. Since then, until the end of 1958, some 4,200 determinations have been made in duplicate on soil samples. The following analyses have been done in routine on soils — pH, Mechanical Analysis, Moisture Equivalent Percentage, Available Potash, Available Phosphate, Sodium Chloride content, free Calcium Carbonate, Percentage Organic Carbon.

B. Comparative Investigation on one Estate

These studies were begun at an estate on the St. Catherine plains in October of 1956. The object was to discover why certain fields of bananas on this estate, although planted at approximately the same time from similar planting material and receiving similar cultural treatments, differed greatly in the time taken to produce bananas and in the amount of count bunches produced per acre. It was decided to restrict these studies to two fields only.

These fields were a good one and a poor one, designated Field 'A' and Field 'B' respectively. Both fields were in banana cultivation until 1938; then sugar cane from 1938-1955 and once again in August, 1955, banana cultivation was resumed.

In Field 'A' the yield of fruit up to the week ending 13th October, 1956, was 297 stems (183 count bunches) per acre, finally yielding 226 count bunches per acre in both the plant and first ratoon crops.

In Field 'B' the yield of fruit up to the week ending 13th October, 1956, was 5 stems (3 count bunches) per acre, finally yielding only 91 count bunches per acre in the plant crop and 73 in the first ratoon.

In both fields the variety was Lacatan, bananas spaced at 12′ x 12′ and with double suckers to each mat. The cultivation prior to planting consisted of ploughing to a depth of 2 feet and later disc harrowing. After planting, the fields were harrowed monthly. Irrigation was carried out once every 2-3 weeks depending on the frequency and amount of rainfall.

In both fields the soil type was the same Caymanas Clay loam. This soil type changed to the Caymanas Sandy loam in some areas of Field 'A'. Caymanas Clay loam is derived from the mixed alluvium of the Rio Cobre. It is a soil which is usually well-drained and on which, given adequate water, bananas do very well.

Fertilizers were applied to both fields by the Estate, 2 ozs. of Sulphate of Ammonia being given to each mat once a month. Additional treatments had been given to Field 'B', within the period of May-June, 1956, with a view to improving the condition of the bananas. These consisted in applying Humber Fish manure at 1 lb. to each mat, applying Guano at ½ lb. to each root, chiselling between the rows, forking around the banana roots and digging of drains at 2 chains apart to a depth of 3 feet.

Chemical tests for available nutrients and also mechanical analyses were carried out on soil samples from each field. The Banana Board Research Department did not then

possess a laboratory so the determinations were done at the Ministry of Agriculture Laboratories at Hope. This facility is gratefully acknowledged here.

The results showed differences in available nutrients to be very small. The Sodium Chloride content of both areas was also well below the limit of 500 ppm for bananas (Dunlop & McGregor, 1932). (Appendix Chem. 1a).

Due to the fact that both fields were flood irrigated, and also that mechanical vehicles passed over both fields during cultural operations it was felt that there might be a great deal of compaction in one or both fields. It was therefore decided to determine monthly the percentage Total Pore Space down the soil profile in each field and compare the results so obtained. The critical Total Pore Space percentage for bananas is at present unknown.

The sampling tool used consisted of an iron core sampler with a sharp cutting edge, patterned on that described by Uhland and O'Neal (1951). Aluminium cylinders 3" long, with a 3" internal diameter fit inside the steel cylinder. An iron shock ring ½" in length and approximately 3" in diameter fits above the aluminium cylinder. Just above the point where the shock ring rests in the sampler are two holes to accommodate a bolt with pin-head to keep the aluminium cylinder and shock ring in place.

All efforts were made to sample when the soil was in a workable condition, i.e. not too wet, for example just after irrigation or a heavy shower. Litter and vegetation was removed from the site to be sampled. A pit was dug at a randomly selected spot each month to a depth of 6 feet where the water-table would allow. Core samples were taken vertically at the following depths — ½-3½", 6½-9½", 12½-15½", 18½-21½", 24½-27½", 36½-39½", 48½-51½", 60½-63½" and 72½-75½". A block of wood was placed in the top of the core and the core driven in by means of a wooden mallet. The block of wood considerably lessened the shock to the soil core.

Each soil core was weighed in the field and a sample of soil from each core was placed in a previously tarred moisture-tight aluminium tin. This was weighed in the field, taken to the laboratory, dried at 105°C. and the percentage moisture determined on an oven dry basis. The sample was also ground to pass a 0.5 mm. sieve and a determination of True Specific Gravity carried out.

An ordinary specific Gravity Bottle was used for the latter determination, and kerosene oil was the liquid utilized. The figures for the weight and for the volume of the soil core taken in the field gave the Apparent Specific Gravity. With these values of Apparent and True Specific Gravities, the Total Pore Space was calculated using the formula.

$$\frac{\text{(True Specific Gravity} - \text{App.Sp. Gr.)} \times 100}{\text{True Specific Gravity}} = \text{Total Pore Space}$$

This method of sampling continued for 5 months when there was a change as follows: Each field was divided into twenty-four sections and four pits of 18" depth were dug by random selection in each field each month. Three soil core samples were taken at each pit at the ½", 6½" and 12½" levels. The reasons for the changes were as follows — (a) The changes in Total Pore Space below 18" were small; (b) In field 'B' the water-table was usually encountered at 26"-32"; (c) The time and labour involved in digging 6 feet pits are great; (d) Random sampling from four spots gives a more representative estimate of the Total Pore Space of the fields; (e) It would be possible to make a statistical comparison of the fields. This new method of sampling continued from May until the end of September, 1957. Records were kept of the cultivation and other treatments given to the fields. Rainfall records were not kept as the fields were under irrigation.

The statistical analyses carried out using the figures for the last six months of the study indicate that there was no significant difference between both fields in their Percentage Total Pore Space at the 0.05 or 0.01 levels (Appendix Chem. 1b and 1c).

During the early period of the soil core sampling, it was noted that in Field 'B' there was a very high proportion of blackened and dead banana roots below approximately 5-6" from the soil surface. It was thought that the death of the roots might have been due to poor drainage. Later with the rising interest in nematodes, notably **Radopholus similis,** in bananas, the Soil Chemist asked the Plant Pathologist to examine both fields to see whether they were infected by nematodes. Investigations showed that the blackened roots were in fact caused by the effects of nematode infestation. It seemed evident that of the factors considered, nematode infestation was a contributing cause to the poor condition of Field 'B', the high water-table there providing conditions favourable to **R. similis.**

C. Survey of Banana Fields and Soils

The survey of banana fields and soils began in a small way in January, 1957. It has as its objective the finding out of the characteristics of good banana soil — the main emphasis being on the physical properties of the soil. This is of importance as the results of this survey should yield facts from which advice may be given as to the suitability of a given piece of land for banana cultivation.

In practice the procedure is as follows: On a property or holding, fields of bananas are judged and placed into three categories of Good, Mediocre and Poor. The judgment is based on the appearance of the bananas in the field, the records (if kept) of the annual yield of the field in count bunches per acre. From experience so far the following yields would place the corresponding fields in the categories mentioned:

under 100	count	bunches	per	acre	per	year	—	Poor
100–200	„	„	„	„	„	„	—	Mediocre
200 and over	„	„	„	„	„	„	—	Good.

Account is taken of the general management of the fields (including Disease and Pest Control), the exposure to the wind, the elevation and local climate. The records (whenever available) which are taken about a field included Acreage, Variety planted, Plant or Ratoon Crop, Spacing, Yield in count bunches per acre per year, Yield in count bunches per acre for the summer period of the year, Fertilizers used and the type, quantity and frequency of fertilizer applications.

From each field soil samples are taken at two depths, 0"-9" and 9"-18". The number of samples taken from a field depends on the number and extent of the soil types found and also on the variation in productivity between one part of a field and another section. Thus if the field contains more than one soil type occupying at least ⅓ the acreage of the field or should there be a very good section and a poor section in one field, then more than one sample is taken.

The following analyses are being undertaken:

(i) **Physical Analyses** included: (a) Mechanical Analysis by the Hydrometer Method of Bouyoucos, (b) Field Capacity — the Moisture Equivalent Percentage is used as an approximate measure of Field Capacity, (c) The Permanent Wilting Percentage from the Moisture Equivalent Percentage: The established and direct method for determining P.W. % is by growing plants (dwarf sunflower more commonly) in soil in a closed tin and determining the moisture content of the soil when permanent wilting sets in. This method is tedious. Briggs and Shantz (1912) suggested that the Wilting Coefficient could be obtained from the moisture equivalent by dividing the latter by 1.84, a value derived by direct experiment on several different soils. Later however it was shown that this relationship was far from constant and could not be used indiscriminately. It is permissible to use this relationship to obtain a quick estimate of P.W. % provided that the correlation is restricted to soils in a closely related group and that the ratio Moisture Equivalent %/Permanent Wilting % is established experimentally for a few typical soils of any group. It is planned to do this for each particular soil type encountered in the survey.

So far determinations (a) and (b) have been carried out on nearly 600 soil survey samples during this two-year period.

(ii) **Chemical Analyses** included: (a) Available Potash from the N/2 Acetic Acid soil extract; (b) Available Phosphate by the Truog Method; (c) pH by the Glass Electrode, (d) Percentage Organic Carbon by the Walkley and Black Wet Oxidation Method.

All the above determinations are being carried out in routine on all the survey samples. The first three determinations are complete on some 570 samples whilst the Organic Carbon determination has been done on about 450 samples.

This survey is being carried out starting with the Parish of St. Mary in which several properties have been included (Appendix Chem. 2). The total acreage surveyed has been approximately 3,200 representing about 6 principal soil types.

It has been found that very few of the properties visited possessed records of the yields of the fields or reliable estimates of the quantity and rate of application of fertilizers. It is as yet inadvisable to list the results although they are promising enough to encourage a continuation of the survey.

D. Ad hoc Experiments

During 1958, two experiments were begun to examine the effect on soil samples of certain methods used in their preparation for analysis. The first is to discover whether

the temperature used in drying a soil sample has any effect on the routine analysis results. In the other experiment soil samples are stored for different lengths of time in tins and in bags before they are dried and stored.

During the latter part of 1958, the Soil Chemist began directing a Micro-nutrient Trial initiated by the Crop Physiologist.

IV. REPORT OF ANALYST (MRS. D. BOLAND)

The Analyst began work at the Research Department on July 1, 1957, one month after the Research Department was housed in the new building. The laboratory had to be organized for routine work and personnel had to be trained. Visits were made to the Agricultural Chemistry Division of the Ministry of Agriculture and Sugar Manufacturers' Research Laboratory to observe work in established laboratories and bulk handling of samples. By 1958, the laboratory was running smoothly and samples were being analysed for projects initiated by various members of staff. The total number of determinations made was 3,958.

A. Leaf Analysis

Analysis of leaf tissue for major elements, N, P, K, Ca, Mg, formed the bulk of the work in the plant section. Results are reported as %N, %P_2O_5, %K_2O, %CaO, %MgO in dry matter.

The analytical methods used are: Nitrogen-Kjeldahl, Phosphorus-Stannous chloride, Potassium-Flame photometry, Calcium-Oxalate procedure, Magnesium-Titan yellow procedure. Baseline values for various elements in the banana plant must of necessity be established so that fertilizer trials and other experiments may be properly evaluated. This section has been working on perfecting the leaf sampling technique with an aim to establish critical nutrient levels in banana leaves. Critical levels are particularly important as an aid to advisory work on fertilizer requirements. Correlation of leaf and soil analyses can also be used in this capacity and it is also possible that this combination will allow detection of nutrient disorders.

(i) **Leaf sampling:** The leaf was chosen as a suitable material for analysis because it is the site of the majority of the plant's active metabolism and is also easily obtainable. Leaf samples are collected using cocoa cutters attached to long sticks. The sharpened end of the cutter is slid along the midrib and the lamina is collected in a calico bag. At first, the whole lamina was taken, this was then reduced to a half, longitudinally. An experiment was designed to find whether the size of the sample could be reduced even further.

(a) **Reduction of size of leaf sample:** A project was started to investigate the possibility of reducing the size of banana leaf sample necessary for analysis to one which will give a similar picture to using half of the lamina. Four samples were collected from the first and fifth leaves of each plant as follows: One whole half side, proximal 2 ft., middle 2 ft. and distal 2 ft. of the remaining half side. The samples were analysed for N, P, K, Ca, Mg. Leaves were numbered in succession downwards, the latest fully opened leaf being taken as the first leaf.

There was no significant difference between concentration of major elements in half the lamina and the middle 2 feet portion of the same leaf. This work was done on fully grown plants and is now being repeated on younger plants using leaves 1 to 5 inclusive to see whether there are any differences. (Appendix Anal. 1.).

The next and probably the most important problem with leaf sampling was to decide which aged leaf would provide the most critical data for sampling. Work has so far been done on the longitudinal half of the first five fully opened leaves from trees of different ages, and from this survey it is hoped to narrow down the choice to a particular leaf.

Hewitt (1954) did leaf sampling for his experiment on 'shot' plants but it is hoped that leaves from a much earlier growth stage may be used successfully.

The main aim in the leaf sampling investigations is to pinpoint a particular portion of a particular leaf on a young plant with well defined characteristics which will give an index of the plant's true nutritional status.

By using a particular leaf and establishing definite nutrient levels or critical levels for various elements associated with production of high grade bananas, any deficiency which is detected through leaf analysis may be corrected before initiation of flowering. "At the time of formation of the flowering shoot, an embryonic bunch of fruit may be initiated. The number of hands on the embryonic bunch will depend upon the nutritional status of the rhizome". (Von Loesecke 1950).

(b) **Leaf samples as an index of nutritional status:** A field of vigorous, high yielding Lacatan was selected. Arbitrary categories for defining different stages of growth were chosen for plants grown from 'sword' suckers: Stage I — Opening of the first blunt leaf to death of the last pointed leaf, Stage II — From the shedding of the last pointed leaf until ⅔ grown or before initiation of flowering, Stage III — ⅔ grown to emergence of inflorescence, Shot — Inflorescence visible, fruit development.

The results of analyses obtained from February-September, 1958, using the first five fully open leaves from plants in each of the above categories indicated the following trends:– Nitrogen-values generally rise to a peak and then fall off gradually. In Stage I plants, the peak is reached in the second leaf while Stage II, Stage III and 'shot' plants show the maximum value in the third leaf; Phosphate & Potash-concentrations decrease with leaf age: with the exception of shot plants, there is a steep fall in values from leaf 1 to 2, then a steady but slower decline to leaf 5; Calcium & Magnesium-concentrations increase with leaf age although there is a tendency for 'falling off' in Magnesium after the third leaf. (Appendix Anal. Diag. 1.).

(ii) **Spray removal:** Leaf samples arriving at the laboratory may be placed into three categories — (a) those which appear clean (b) those sprayed with Bordeaux mixture (c) those sprayed with oil. It is not yet known to what extent oil residue interferes with analysis for major elements. 'Clean' samples are usually contaminated with dust which must be removed. Samples sprayed with Bordeaux form the bulk of samples we now receive and the spray material, which contains calcium, must be properly removed before calcium or potash determinations can be done. The need for an efficient spray-removing substance therefore becomes a primary one. Several substances could be used but whatever substance is chosen should also exert the minimum effect on the nutrient content of the leaf samples.

Spray material on banana fruit arriving at the wharves is removed by dipping the fruit into a solution of sodium bisulphate, which is in fact, mainly a solution of dilute sulphuric acid. A range of sulphuric acid solutions, water and two detergent solutions Teepol and Triton were tried on the leaf samples.

From the trials, it was found that Teepol solution contained some potassium.

Results of analyses on leaf samples washed with the various solutions showed that the procedure exerting the lowest leaching effect on the nutrients and the highest efficiency in removing the Bordeaux spray mixture was 0.2N sulphuric acid solution followed by Triton solution. A further batch of samples washed solely with 0.2N sulphuric acid solution and two rinses of distilled water showed that no nitrogen was lost in the wash solutions, phosphate loss was negligible and loss of potash amounted to about 1% of the final result.

After spray removal, the samples are dried at 86°C and ground to a fine powder. Final drying is done at 105°C, to drive off residual portions of moisture. The samples are then ready for analysis.

B. Analysis of Fruit

(i) **Tenderness of fruit in relation to potash content:** Fruit from Bowden wharf has frequently received worse reports on the condition of arrival in the U.K. than that from other ports. There have been frequent observations on bruising of banana fruit in the Bowden area, making them ready prey to fungus infection. A theory by May (1927) that 'there is a striking relation between Potash content of the plant and freedom from disease' led to the speculation that bruising may be facilitated by, or be indirectly related to a low Potash content in the green fruit skins and that skins in the Bowden area may be lower in Potash than those of other areas. Twenty-one hands of green bananas were taken from different bunches on Bowden wharf during loading. Four similar samples from St. Catherine plain were used as controls. Random samples of three fingers were taken from each hand. The green skin was stripped by hands (tips left intact), wiped with a damp cloth, cut into small pieces and dried. Each sample was then ground, bottled and dried prior to testing.

Potash determinations based on the dry matter were carried out. (Appendix Anal. 2.). There was no indication of any appreciable difference between the Bowden and St. Catherine samples.

V. REPORT OF AGRONOMIST (V. R. LUMSDEN)

The period covered by this report has been fairly frustrating for the division, particularly in respect of the number of experiments that had to be given up before any useful results could be obtained. The factors contributing to this are mainly the replacement of

bananas by sugar cane. The prolonged drought of 1957 severely affected a number of experiments particularly the sucker timing plots in St. Mary and parts of St. Ann.

A. Fertilizer Trials

(i) **Comparisons:** At the start of the period covered by this report, six experiments involving a comparison of various fertilizers, which had recently found favour with banana growers, were in progress. In these experiments Fish manure, urea and various proprietary mixtures of inorganic fertilizers were being compared with standard mixtures. Three of these were treated on the St. Catherine plains, two in the hills of St. Mary and one on the coastal belt of Portland. Unfortunately five of these experiments had to be abandoned, four before the plant crop had completed shooting. Among the five experiments lost were those which involved the testing of the frequency of application of nitrogenous fertilizers.

(a) **St. Catherine plains:** From the results all fertilizer treatments were significantly better than the untreated controls. Between the fertilizer treatments the NPK/Sulphate of Ammonia was better than the Low Humber fish but there was no significant difference between the others. Using the present buying system of grades, thus excluding any stem below a six hand, it was again found that the fertilizer plots were all significantly better than the control but there was no difference within the various fertilizer treatments.

There was no difference between the control and the fertilized plots nor within the various fertilizer treatments in respect of the weight of the fruit. The figure used was av. wt./hand in lbs. A figure was calculated for the average count bunches/acre and here the fertilized plots were significantly better than the control but did not differ significantly within themselves.

From the results of this experiment it would appear that urea is as effective as sulphate of ammonia in supplying nitrogen for bananas and can be used on equal nitrogen basis to replace sulphate of ammonia.

The Humber fish manure has not shown any benefits over the NPK/Sulphate of Ammonia and consequently its higher cost must militate against its use on the St. Catherine plains. (Appendix Agr. 1.).

(b) **St. Mary:** The object of this experiment was to determine the effectiveness of urea as a source of N and Humber Fish as a complete fertilizer for Lacatan bananas.

The fertilizers applied were calculated to supply an equal amount of plant nutrients although the Albatros supplied slightly more N and slightly less K_2O than the others. This experiment, however, was abandoned when the whole field was fertilized with AIBGA Mixture C by error. Reliable records were obtained for the plant crop. In respect of the average no. of hands/stem, the average no. of hands/stem/12 months, the av. wt./stem and the av. wt./stem/12 months there was no significant difference between the treatments.

The figures for the calculated number of count bunches/acre/annum showed no differences within the fertilized plots but the fertilized plots were all better than the control plots. In arriving at the figures for the calculated count bunches/acre/annum, five hand stems and lower were excluded from the calculations. (Appendix Agr. 2a).

As there was no significant differences between the fertilizer treatments, the average yield from each was calculated to be 113.4 count bunches per acre. If the costs of the different fertilizers are worked out, plus the cost of application at six shillings per acre/annum, and the value of a count bunch is taken to be ten shillings, the results indicate that, on this particular soil, not only is the use of fertilizer advisable but the use of an artificial fertilizer is a safer investment than the use of Humber Fish manure. (Appendix 2b).

(II) **NPK trials**

(a) **3^3 Factorial experiment in Portland:** The object of this experiment was to determine the nitrogen, phosphate and potash requirements for bananas on the soil type in this area. The soils in the area are derived from soft white limestone and are generally low in phosphate with a variable potash status and alkaline in reaction.

The treatments consisted of sulphate of ammonia, single superphosphate and muriate of potash, each at three levels, three times a year.

The results for the plant crop and four ratoons were analysed. The most significant result was that obtained in response to potash and this applied both to the weight of the fruit and the number of hands/stem. It was observed that in the plots receiving no phosphate or potash, high nitrogen fertilizing had a depressing effect on yield. This then accounts for the slight falling off of yield with increasing nitrogen levels.

There was no significant response to phosphate although the soil levels were low and this was probably due to the high fixation of phosphate for which these soils are noted.

It would therefore appear that the most important fertilizer here is potash, the best results being obtained when applied with nitrogen. (Appendix Agr. 3).

(b) **3^3 Factorial experiment in Christiana area:** The treatments in this experiment were the same as in the previous 3^3 experiment. Unfortunately one block was lost and only two blocks remain.

The soils in the different sites were derived from Trappean shales and were found to be low in phosphate and potash, and acid in reaction. There was a good response to all three fertilizers and particularly so in respect of phosphates. The K_1 level of potash appears to be adequate as there is quite a large decrease in yield at the higher level. These results appear to hold good both for average no. of hands/stem and also for average weight/hand (lbs.) (Appendix Agr. 4).

(c) **3^3 Factorial experiment in St. Ann:** The treatments in this experiment were the same as in the two previous 3^3 experiments. Unfortunately this experiment was dug out and the field replanted with sugar cane immediately after the plant crop was reaped. There were no significant responses to any of the treatments either in time taken to reaping, average grade (no. hands) or average weight/stem.

This was probably due to the fact that the area had previously received high levels of fertilizing for canes and the residual effect was quite adequate for the growth of bananas. (Appendix Agr. 5).

(d) **3 x 2^2 Factorial experiments:** These experiments were laid down with the object of attempting to find out the nitrogen, phosphate and potash requirements on various soil types in the island. A large number of these were laid down but during the period covered by this report only seven sites remained.

These experiments were sited on soils derived from soft white limestone with the exception of site I which was on soil derived from carbonaceous shale. These soils were all low in available phosphate and while the available potash level was variable it tended to be low. Site I was high in available potash.

The responses to the fertilizer varied from site to site but in the final analysis the interaction between sites and the main treatments was not significant. In respect of grade (no. of hands)/stem the response to nitrogen was most variable. The trend was towards a slight increase at the N_1 level and a decrease at the N_2 level but this was not consistent at all sites. There was a significant decrease in yield at the N_2 level at site VI and this appeared to be a case of high N depressing yield in the absence of potash or phosphate.

The response to phosphate was consistent with the exception of site I. The trend was towards an increase in yield with phosphate and at site VI this increase was a significant one. The same was also true of the response to potash. The exception here was site III. The increase at site VI was again a significant one.

The results for the average weight/hand were similar to that obtained for the average no. hands/stem. Phosphate gave significant increases at sites II and VI while potash gave significant increases at sites I, II, VI and VII.

The increases due to potash at site I was curious because this is an area which is very high in available potash and very low in available phosphate. The areas where no satisfactory response was obtained from phosphate, although the phosphate status is low, are all areas where phosphate fixation takes place in the soil and a possible line of enquiry is now the application of phosphate together with manure or compost. (Appendix Agr. 6).

Note: Several of the above fertilizer experiments were originally laid down by Messrs. E. Trevor Ellis and R. E. Osborne when they were working for the A.I.B.G.A.

B. Defoliation Experiment — St. Catherine Plains

This experiment was designed to determine the effect of loss of leaves, at different stages of the plants' growth, on the fruiting records of the plants.

The experiment was laid down in a young "plant" field and the plants were selected carefully for uniformity in height and general appearance. The following defoliation treatments were given: (a) When the plants were 3½ months old, all the leaves except the last two fully opened leaves or the last fully opened leaf plus a large unfurling heart leaf were removed from one set of plants; (b) At six-weekly intervals the leaves from other sets were removed. One set was left as a control. The plants which lost their leaves at five months old and earlier took a significantly longer time to shoot than the plants losing their leaves at 6½ months or later and the control. There was no difference between those losing their leaves at 3½ months and those losing their leaves at 5 months. There was also no differ-

ence between the plants losing their leaves at 6½ months, 8 months and the control.

The average grade (no. hands)/stem was also affected. There was no difference between plants losing their leaves, at 3½ months, 8 months and the control, but there was a significant difference between those losing their leaves at 5 and 6½ months and those losing their leaves at 3½ months or the control. (Appendix Agr. 7).

Thus the critical period seems to be about 5-6½ months for grading and about 5½ months for time to shooting. In relation to leaf spot control this is important because growers sometimes get caught with a severe attack of leaf spot at this early stage of growth.

C. Sucker Timing Observations

Observation plots were established at various altitudes throughout the banana growing areas in Jamaica to determine the time taken by a "peeper" to produce fruit. The need for some knowledge of this aspect of banana growing was deemed necessary when the emphasis was placed on producing fruit in the summer months.

Ten suckers at the "peeper" stage were marked in a large number of plots at various altitudes throughout the island in each of the following months, May, August and December 1956 and March 1957, and records were taken of their growth until shooting.

This experiment is still in progress since at the higher altitudes some of the plants marked in December and March have not yet shot. The severe and prolonged drought of 1957 severely affected the plants in some plots, particularly St. Mary, and these badly affected plots have been omitted from the calculations. This report is an interim one based on the shootings from the May-marked "peepers" in ratoon crops.

Owing to the fact that suckers were marked at such an early stage, losses from suckers dying back, or being affected by cuts from weeders, were sustained in some plots. In other instances there were losses from blow-downs. Because of these losses, calculations were worked out at 80% of the plants in the plot. A further figure of 60% of the plot was used because in many instances one or two plants were severely affected either by virtue of damage, position in the root or borers and so failed to develop normally. These few plants took several months longer to shoot and so upset the average for the plot. The calculations were also based on 50% of the plot but there was no difference between 50% and 60% of the plot.

The correlation coefficients between months to shooting and altitude were worked out and these were found to be significant. At 80% and 60% of the plants in the plot the correlation coefficients were .7212 and .7649 respectively and both these figures were highly significant. Thus, as altitude increased so did the time taken to shooting.

The regression coefficient of the time taken to shoot on the altitude was then calculated and then tested by calculating the "t" on the regression coefficient. Although both coefficients were significant, the regression coefficient on 60% of the plants was more highly significant than that on 80% of the plants.

From the results it would appear that for every 100 feet increase in altitude there was an increase of .36 months in the time taken for the plants to shoot. Unexpectedly the greatest variation in the growth of the bananas occurred at the lowest altitudes. (Appendix Agr. 8. and Diagram 2).

The overall time taken to shooting can be affected by field conditions and cultivation management. Thus plants grown in a mixed cultivation, in heavily shaded areas and those affected by disease take a much longer time to shoot.

D. Relationship between Height at Shooting, Average Girth and No. Hands at Different Sites

The shooting records from experiments at four different sites, A, B, C, D, were picked out and calculations were made to determine whether within any given field, there was any relationship between the height and girth of a plant at shooting and the grade of the fruit produced.

At any one site the differences between the average height at shooting for the different grades were all highly significant with only two exceptions, viz, the differences between a five and six hand at sites B and D.

The girth of the plants was measured at 24" from ground level. Here again at any one site the differences between the average girth at shooting for the different grades were all highly significant with two exceptions, viz, the differences between a five hand and a six hand at site B and the differences between an eight hand and a nine hand at site D. In the last instance, however, the number of nine hands was very small and this would probably account for the differences not being significant. (Appendix Agr. 9).

It may therefore be concluded that in any uniformly treated field the taller and more robust plants will give the higher grading. Thus any treatment which will produce these qualities in the plant is a desirable one.

E. Relationship between Time from Shooting to Reaping and the Month of Shooting at Different Altitudes

Maturity in the field is at present based on the state of "fullness" of fingers. It had been noticed that fruit appearing in the winter months tended to take a longer time to mature. The records from two different sites were obtained and the time taken from shooting to maturity for a number of plants, shooting in different months, picked out. The two sites used were at sea level in Portland, and 2,200 ft. up in the hills of Westmoreland.

It was found that there was a difference of nine days in the overall average of days from shooting to reaping between the two sites. The monthly mean temperature in these regions of Jamaica varies between 75°F-81°F. at sea level and 66°F-73°F. at the higher altitude (Leach, 1946).

At sea level the plants shooting in the months of April, May, June and July took a much shorter time to mature than the plants shooting in the months of October, November, December and January. The differences corresponded very closely to the differences of temperature in the months during which the fruit was developing. Thus there was a difference of 19 days in the time taken for fruit to mature, between those shooting in May and those shooting in November.

The same thing applied to the fruit from the higher altitude. Here the difference between the May and November shootings was 23 days (Appendix Diagram 3).

Thus a range of mean temperature of only 6°F can cause a difference of approximately three weeks in the time taken for the fruit to mature.

F. Crop Timing Demonstrations

The necessity for producing the bulk of bananas in the summer months has been stressed and a method of approaching this problem is now under observation. This method is based on controlled pruning as outlined in the Banana Board Research Department's Occasional Bulletin No. 1.

At present nine plots have been laid out in different parts of the island. These consist of one in a 12 month area, six in 15 month areas and two in the long-term areas. These plots are to be compared with adjacent plots pruned according to the standard estate methods in order to test whether the "controlled" pruning will, in practice, increase the amount of fruit produced in the summer.

VI. REPORT OF PLANT PATHOLOGIST (R. LEACH)

A. Banana Leaf Spot

(i) **Oil spraying experiments:** When the first Annual Report of the Research Department was published, low volume mechanical mist spraying with oil showed promise of proving a boon to banana growers in Jamaica in their efforts to control leaf spot. This was due largely to the ease with which the new fungicide could be applied in place of the laborious high volume Bordeaux spraying and because it could be used in areas too short of water for high volume spraying. The spray oil also has a remarkable fungistatic effect on the growth of **Mycosphaerella musicola** in the banana leaf after infection has occurred, so that plants, heavily infected up to the time of shooting, can have their fruit saved by oil under conditions where Bordeaux spraying can only fail. Oil has, in fact, saved many thousands of bunches of bananas in this way in Jamaica.

Unfortunately time and experience have shown that although these highly desirable features of oil spraying are of great value, other undesirable features have gradually become more noticeable during the period under review. Unless these can be eliminated, the time has now come when a grower has to decide whether the advantages of oil commercially outweigh the disadvantages.

Unlike the conditions prevailing in the French Antilles where the beneficial effect of oil has been measured simply against the ill effects of no spraying, in Jamaica the oil spraying has also to be compared with the well established and successful high volume spraying with Bordeaux mixture. Many growers accustomed to spraying with Bordeaux disliked oil spraying from the start because of the less attractive colour of the oil sprayed foliage in some localities. As Bordeaux spraying is, however, expensive for the small grower, oil spraying was encouraged in Jamaica after initial trials had clearly domonstrated an equal effectiveness in controlling leaf spot as that originally obtained in the French Antilles. The

main difference between the two areas has been the greater phytotoxicity in the Jamaican banana plantations where light brown flecking of the leaf blades becomes increasingly noticeable as the leaves receive repeated applications of spray oil. There appeared to be remarkably little adverse effect of oil on the grade and weight of fruit produced in oil sprayed fields considering how, under the microscope, so much damage is seen to be done to stomata and tissue adjacent to vascular bundles.

In the 1956/7 Report, an apparently new trouble associated with oil spraying was recorded, namely, sheath splitting. The first case of this occurred where sudden growth followed after the end of a long spell of drought. Sheath splitting, however, became increasingly prevalent towards the end of the wet season in 1958 when the full significance of it was first appreciated. This trouble does not occur either on Bordeaux sprayed or on unsprayed bananas. Mr. A. N. Lynch, Assistant Executive Officer of the A.I.B.G.A., has been observing sheath splitting with particular interest in view of his close association with growers. According to him, there is every indication that the Lacatan banana is much more susceptible to sheath splitting than the Robusta, although both show the effect of phytotoxicity in the foliage. An experiment, described later, comparing three new spray oils has tended to confirm this view because in the two Robusta blocks at Bog Walk no cases of sheath splitting were recorded, whereas there were several cases noted among Lacatan plants in St. Mary. In this connection it should be noted that Robusta is the main variety both in the French Antilles and in the Windward Islands where phytotoxicity of oil is not considered serious, although, in the Windward Islands sheath splitting has been seen.

Originally, in Guadeloupe, oil was applied at the rate of 2½ gallons per acre and phytotoxicity was apparently negligible, yet, in some parts of Jamaica, when only 1 to 1½ gallons of oil are applied at 3-weekly intervals, phytotoxicity is conspicuous even during the wet seasons. Unfortunately during the height of the infectious season for leaf spot the cycles have to be shortened to 2 weeks where the disease is inclined to be severe, especially nearby to unsprayed bananas.

Phytotoxicity is definitely worse on some Jamaican soils than on others being especially noticeable wherever banana plants are subject to the slightest drought. It is not severe in well irrigated plantations.

The greater incidence of sheath splitting in ratoon plants suggests that the adverse effect of oil is cumulative.

The small amount of noticeable phytotoxicity in the islands mentioned above would seem to be due to the greater depth of their free draining volcanic soils in which the bananas develop a deep root system, better capable of withstanding short dry periods than on the heavier Jamaican soils. Not until sheath splitting became widespread did the Research Department seriously question the advisability of oil spraying and initiate experiments to evaluate phytotoxicity by direct comparison with water miscible sprays.

Although oil spraying meets with disfavour in many parts of Jamaica, there are still several growers who prefer it and are anxious to continue with its use. One of the biggest problems facing the Research Department is that of assessing the effect of oil on the shipping qualities of the fruit. There is, for instance, a possibility that the property of the oil which weakens leaf bases, sufficiently to cause sheath splitting, may also be capable of weakening the tissues of the finger stalks. This might make them more susceptible to the type of damage in handling which later results in the development of Santa Marta Stem End Rot.

The undesirable feature of phytotoxicity prompted the Research Department to request the Oil Companies, in Jamaica, to produce less toxic spray oils, without impairing their fungicidal properties. The Department has insufficient staff to undertake extensive oil trials, so the policy adopted, in co-operation yith the Oil Companies, has been for the Companies to do their own screening trials and when improved marketable oils are discovered, the Research Department carries out field trials with the new product. Two such trials have been undertaken during the period under review.

The fungicidal properties of oil are readily assessed by the normal procedure of recording leaf spot in Jamaica. Phytocidal properties are by no means so easy to measure. Two standards have been used, namely, gross discolouration (yellowing) of the undersurface of leaves and intensity of "flecking" in the leaf tissue as observed by transmitted light in a dark room. In either case, sectors of individual leaves on non-fruiting plants as far as possible of uniform height, are collected at random in an oil sprayed plantation. Each leaf sample is divided down the midrib into two halves which are marked with a wax pencil. All the leaf samples are shuffled like a pack of cards before being examined. Whichever standard

of phytotoxicity is used, the samples are sorted at random into four categories — 0 (None), 1 (Light), 2 (Medium), 3 (Heavy). A general mean for each oil is thus obtained. Usually the 5th to the 7th leaves from the top of each plant provide the best sampling material. If leaf spot is prevalent, the flecking method is not always easy to interpret, due to the presence of the earliest streak stage of the spots. Unfortunately trials employing the use of mechanical knapsack mist spraying machines require much larger experimental plots than those for high volume spraying, due to the extensive drift of the smaller spray droplets. This entails difficulty in finding sufficiently uniform areas for carrying out spraying trials of this nature where, at the same time, incidence of both leaf spot and phytotoxicity can be expected to be high on non-irrigated land in Jamaica. The method employed has been to have replicated blocks using different estates as individual blocks in which the different treatments were randomised. Each individual plot was at least 1 acre in size. There has been difficulty encountered in obtaining even this arrangement for the trials due to variables such as soil, slope of the land and the presence of coconut trees which complicate matters in providing shade.

(a) **Comparison between four new spray oils screened by one Oil Company:** This trial was started in November 1957 and was completed in April 1958. Four different oils (A, B, C & D) were sprayed on each of four different estates, the applications being supervised by a staff member of the Oil Company. Intensity of leaf spot was assessed in each plot at the start of the experiment. Records were first taken in January, at which time, general observations regarding signs of phytotoxicity were made and, later, phytotoxicity tests were made by means of the flecking test on three of the estates. The result of this trial showed that all the oils gave good and practically similar control of leaf spot, but the phytotoxicity of two oils (B & C) was significantly less than that of the oil (A) claimed by the Oil Company to be very similar to that used originally in Jamaica. The slight improvement in the two oils regarding phytotoxicity was considered sufficient to warrant a changeover to one of these oils, if the price was reasonable, even though they had not shown the amount of improvement really desired.

Difficulty arose in choosing between the two oils and this was done by referring to notes made throughout the trials, and, as a result, Oil C was chosen. (Appendix Path. 1.).

(b) **Comparative trials between new spray oils marketed by 3 different Oil Companies:** This trial was carried out in Bog Walk and St. Mary, in the most uniform, unshaded plantations that could be found outside the irrigated plains and in a heavy leaf spot area. The lay out consisted of 3 blocks, divided between two estates, the three oils being replicated in each block. The results showed no difference in the effect of these three new products either in regard to leaf spot control or in phytotoxicity, leaf spot control being in all cases of a high standard. (Appendix Path. 2).

(ii) **Mist spraying experiments with water miscible fungicides:**

(a) **Comparative trial with four copper fungicides:** In view of the adversity experienced with oil spraying in many important banana growing areas, a trial was planned, just prior to the departure of the Plant Pathologist on overseas leave, to test the effect of Copper Oxychloride from two sources, Cuprous Oxide and Bordeaux mixture — all applied in low volume by the mechanical mist spraying machines used in oil spraying.

Treatments were applied, fortnightly, down every row. This is essential for success with low volume mist spraying, using non-eradicant fungicides, in order to provide the best chance for the spray reaching the undersurface of the youngest leaves. In young bananas the spraying should be adjusted to the height of the plants because this type of spray, simply drifting on to the upper surface of the leaves, cannot control ascospore infection.

Unfortunately the Copper Oxychloride was applied at double the recommended strength but the trials showed conclusively that this type of spraying can keep bananas under a high standard of leaf spot control, especially if they are not closely adjacent to a source of heavy infection.

The trials showed that provided a field of bananas is brought under a high standard of control, prior to the wet season — August to October — even the tallest Lacatan bananas can be maintained at that standard using only 4 gallons of a spray mixture per acre (Appendix Path. 3).

The Senior Field Officer, Mr. W. G. Chambers, was in full charge of the spraying experiments recorded above and this extra assistance given has been greatly appreciated.

B. **Borer Weevil (Cosmopolites sordidus)**

Investigations into the control of banana borer started in June 1956 and were continued until the end of 1958. An unsuccessful attempt to introduce the predaceous beetle, **Plaesius javanus,** into two banana plantations was followed by experiments in the use of insecticides.

Dieldrin has effected a high degree of borer control over a remarkably long period of time following one application to the soil. The borer population in banana plantations was found to be somewhat lower than expected when a survey was made in 1957-58.

(i) **Borer survey:** Originally it was intended to make an islandwide survey of borer population as a preliminary study of the borer problem, but when the initial work showed a comparatively low borer infestation, the work was stopped in order to relieve staff for other more urgent investigations. There is every indication, for instance, that nematode damage far exceeds that of the banana borer in general throughout the island and many problems associated with leaf spot control are also requiring more attention. Experiments have shown in the meantime that wherever there is evidence of borer damage, control of the insect can be well maintained by the use of Dieldrin. The result of the survey is summarised in Appendix Path. 4.

(ii) **Borer control experiments:**

(a) **Comparative insecticide trials:** A preliminary trial was carried out comparing three insecticides with untreated plants in four, ½ acre plots. Dieldrin applied in water on to the ground close around the base of banana mats achieved a much higher standard of control than either B.H.C. gamma isomer or Cosmopolicide 109. (Appendix Path. 5).

(b) **Effect of borer on growth of banana plants:** An experiment was carried out to study in detail the effect of borer damage on the growth of banana plants on 6 acres of a well cultivated ratoon field, maintained under a high standard of leaf spot control, at an altitude of 800 ft. Two Dieldrin treatments were used which both maintained a remarkably high standard of borer control throughout the 2-year duration of the experiment, even though, in one of the treatments, only one application of Dieldrin was given and that at the start of the experiment.

The Dieldrin was applied on to the soil close around the plants, in the form of a 50% wettable powder mixed (A) with Gypsum and (B) with artificial fertilizer. These methods facilitated the application of the insecticide and overcame the inconvenience of applying it in water. The Dieldrin was applied when the soil was damp, and after first removing trash from the base of the plants. (Appendix Path. 6a).

In each 1 acre plot, 15 borer traps were set at the base of the same plants approximately every 2½ months. At regular intervals, growth and cropping records were obtained from each trapped plant and four plants around it. Detailed information was thus obtained about the behaviour of plants in 450 banana mats in 6 acres of a typical, well maintained, unirrigated hillside plantation.

The average number of borers caught in the untreated plots just after the start of the experiment was 2.13 per trap, the numbers varying afterwards, and near the end of the experiment the average was much the same, namely 2.17.

It was concluded that there were too few borers present to affect adversely the growth or cropping of the bananas as all the records, over the period of 2 years, showed that the control of borers had not affected the growth of the bananas in the treated plots. (Appendix Path. 6 a & b).

As this was the case, the data from all the mats could therefore be grouped together for the purpose of analysing the growth data obtained. Some records of grade and times of shooting were lost from various causes such as a delay in visiting plots, blowdowns and pruning mishaps. An unbroken history of parents and followers, however, was obtained from nearly 200 mats over a period of 2 years.

The following information was obtained in this way from the experiment: The rate of growth of followers varied considerably at different times of the year and was very slow in the first quarter of the year even when there was not the usual dry period, as in 1957. (Appendix Path. 6c). Individual mats behaved uniformly throughout the experiment. The height of shooting and the grade of fruit produced in each mat remained constant. A definite relationship existed between plant height and grade of fruit, the tallest plants giving the best grades (ref. Agron. Rept. p. 15).

The size of a follower at the time that a parent plant shot had no effect on the grade of fruit borne by that parent, nor later by the follower itself, when the followers concerned

were never more than three-quarters of the height of the parent when it shot. Approximately three-quarters of the mats produced only two bunches during the 21 month period under review, although a few produced three bunches during that time. The mats which produced three bunches bore fruit consistent in grade with that of mats producing fruit at longer intervals. This would seem to indicate that the succession of followers had been backward for the most part. (Appendix Path. 6d).

The general conclusion reached from a study of the behaviour of the plants in this experiment was that ratoon plants shooting sub-standard fruit for any one plantation might well repay being given individual attention for their betterment; and that "insurance" suckers should be left to obtain a faster succession of suckers. It would seem that little can affect yield per acre per annum more than backward suckering which, in many cases, can be exaggerated by careless pruning and injury to suckers during cutlass weeding.

C. Blackhead Toppling Disease

"Blackhead disease" of bananas was first discovered and described in Jamaica over 40 years ago by Ashby (1915) when Gros Michel bananas were apparently affected only in a few districts. It was caused by the nematode, **Tylenchus similis** Cobb. Nothing seems to have been heard of this disease again until it was rediscovered in the parish of Portland in 1957, Martyn (1949) making no mention of it in his list of plant diseases in Jamaica.

Due acknowledgment is here recorded for the kind help given by Mr. F. G. W. Jones, Director of the Department of Nematology, Rothamsted Experimental Station, England, for having the nematode identified. The nematode is the "burrowing nematode", now called **Radopholus similis** Cobb.

The disease has been renamed blackhead toppling disease to associate it more with its most serious symptom, the corm, together with many of its exposed roots, being black when uprooted. In a wind, a corm riddled with borer tunnels has a tendency to break at ground level without exposing its roots. Nematode damage is frequently mistaken for borer damage because roots killed as a result of nematode infestation often die back to their origin, an inch or so within the corm. Cavities left by the rotted primary root bases are similar in size to those of borer tunnels. When a toppled over plant, with roots exposed, is examined casually with a cutlass, the corm is usually just cut tangentially, exposing a number of dead root cavities which can easily be mistaken for borer tunnels. A great deal of nematode damage has undoubtedly, in the past, been blamed on the banana borer in this way.

Evidence has been accumulating which indicates that this disease is causing serious losses, principally due to "blowdowns", quite apart from its possible adverse effect on grade and weight of fruit produced.

The disease has been investigated from the following aspects:– (a) population of nematodes in banana tissue, (b) treatment of planting material, (c) treatment of established banana plants and (d) banana varietal resistance.

(i) **Population of nematodes in banana tissue:** On one banana sucker, two primary roots were found to be almost uniformly light purple in colour for a distance of approximately 3½" without any sign of blackening. In this condition the cortex was expected to be heavily infested with nematodes. A less uniformly affected root is likely to have some of the cortex blackened due to invasion by secondary organisms, such as fungi and bacteria. The nematodes migrate out of the tissues when this happens so that blackened roots do not provide suitable material for making a population count. The nematodes in these two roots were collected into a measured volume of water, and, by using a constant drop technique, the total population was readily calculated. The population of nematodes averaged 3,205 per root or 1.9 per cu. mm. of cortical tissue.

(ii) **Treatment of planting material:** Probably all banana planting material in Jamaica is now infested to some extent with the **R. similis,** much of it heavily so. Cases are known where serious loss from toppling have even occurred in "plant" crops in land which has not carried bananas for many years. This has doubtless been due to the banana heads being infested at the time of planting. Incidentally, **R. similis** does not appear to invade sugar cane roots extensively because cane shows no ill effects from being planted after bananas whereas bananas become heavily infested with the banana nematode after a cane crop. This is probably due to the use of infested planting material.

In the preparation of land for planting bananas, even if a field is treated overall with a nematocidal fumigant, the effectiveness of the treatment is largely nullified if infested planting material is then used. It is highly desirable, therefore, that banana planting material should be treated in such a way that the nematodes in or on it are either killed in situ or

are prevented from invading the new root system of a "plant" crop. Hot water sterilization is possible but a difficult operation with a bulk of large banana heads. Experiments were started, therefore, in the first instance, using nematocides at planting time.

(iii) **Use of nematocides at time of planting:**

With the help of Mr. H.E. Wheeler of Egypt Pen, St. Mary, a preliminary trial entailed (a) immersion of heads in solutions or emulsions of nematocides in water just prior to planting and (b) placement of a solid nematocide in the planting hole.

The various treatments were not replicated but they were confined to a small patch of uniform soil. There was a severe and prolonged drought after planting so that the bananas grew very slowly; this perhaps improved the test because the restricted root growth would favour infestation by the nematode.

As the surface of bruised roots soon darken, each root has to be cut lengthwise down the middle to ensure correct identification because injury due to nematode infestation is always recognisable as a purple, reddish or orange-yellow discolouration where the cortical tissue joins the vascular cylinder. To obtain a Disease Index No. the roots are sorted into four grades of disease — 0 (None), 1 (Light), 2 (Medium), 3 (Heavy). The percentage of roots falling into each grade in any one sample is multiplied by the corresponding grade number, the total being then divided by 4.

In this experiment, in which the whole root system of each plant was examined, Nemagon and Parathion effected a high degree of control although the Nemagon Emulsifiable Concentrate (N.E.C.) was toxic at the higher concentrations. Vapam was ineffective as used in this trial in which it was also non-phytotoxic (Appendix Path. 7a).

As a result of this trial, further experiments were designed to use Nemagon in both liquid and solid form, it being much more safely handled than Parathion.

A large scale randomised experiment was started in July, 1958, to compare the effect of Nemagon added as granules and as N.E.C. at planting time on irrigated land. The granules, in this experiment, were applied mixed with Gypsum as a filler and were dusted around the base of the banana heads after they had been placed in the planting hole, similarly N.E.C. was sprayed on to the base of the heads. The only results obtained by the end of the year showed that the Nemagon E.C. was slightly phytotoxic used in this way but the granules were not. (Appendix Path. 7b).

Mr. A. J. Carrrington, of T. Geddes Grant Ltd., kindly assisted in an experiment designed to test the effect of fumigating banana heads with Methyl Bromide prior to planting. Thin polythene tubing, 22½" wide, was cut into equal lengths sufficient to hold ten heads, then tied at both ends. The approximate cubic capacity of each bag was computed to be 2.81 cu. ft. when filled with the banana heads. Ten heads together were subjected to the action of the fumigant for varying lengths of time before being planted. The banana appears to be very vulnerable to Methyl Bromide because all treatments killed the heads, even with the shortest fumigation, namely 15 minutes, using the Methyl Bromide at the rate of 2–2.6 lbs. per 1,000 cu. ft. A repeat experiment using half the quantity of Methyl Bromide was equally unsuccessful.

As a result of his experiments, Mr. C. A. Loos, of the United Fruit Company, in a personal communication, suggested paring down the planting heads until absolutely no sign of discolouration due to nematode infestation is seen in the corm. This can frequently result in the head being cut down to such an extent that the new plant has to originate from a bud in the axil of a young leaf base. An experiment was carried out using this treatment both with and without the use of Nemagon granules in the planting holes. By the end of the year the only results obtained showed that the paring treatment was too severe for normal planting because the mortality rate was high. This treatment, however, is advocated more in the establishment of healthy nurseries than on a normal field scale.

(iv) **Nematocide treatment on established banana plants:** An experiment was carried out to simulate the effect of applying Nemagon E.C. around the base of ratoon plants, and then flooding with water to get the nematocide down to the roots. In the same experiment Nemagon granules were placed into holes made with an auger on each side of young followers to see whether small amounts of Nemagon could be effective in controlling the infestation of roots growing through the most heavily diseased regions of the root system i.e. close to the corm. Three other experiments were carried out in which individual followers received different treatments with Nemagon E.C. either watered on to or injected near the base of individual followers.

(v) **Banana varietal resistance to Radopholus similis:** In co-operation with Mr. R. E.

Osborne, Chief Agronomist, Ministry of Agriculture, who is in charge of the banana breeding station of the West Indies Regional Research Centre, a banana variety field trial was carried out to test for differences in varietal susceptibility.

Six varieties were used, three commercially cultivated triploids and three tetraploids still under trial at the breeding station. The experiment was started in the corner of an irrigated banana field which was just due to be cleared for sugar cane. Suckers of the different banana varieties were planted in the experimental area — (a) on the site of the previous banana mats and (b) in the interspace between the old mats.

It was considered that in this way the varieties would be subjected to two different levels of infestation. Unfortunately all the planting heads were not collected from the same source and varied in size between the different varieties, but they were all free from obvious signs of nematode infestation. Half the plants were dug up and examined on 3/3/58 and the other half on 24/7/58.

Although the varieties grew at different rates, thus confusing the issue to some extent, significant differences established within the experiment indicated strongly that (a) the triploid bananas, notably Lacatan and Robusta, would seem to be more susceptible to nematode infestation than some of the new tetraploid seedling varieties; (b) nematode free banana heads become attacked by **R. similis** even if planted in the interspace between old mats, although the chances are that they will be less attacked there than if planted on the site of old mats. The increasing infestation of roots in successive ratoon crops can be visualised readily by comparing the amount of infestation on March 3rd and July 24th in this experiment because the increase in the interspaces was quite considerable in that comparatively short time. (Appendix Path. 8).

D. **Speckle (Fruit Spot)**

Speckle is one of the most disconcerting of all banana diseases in Jamaica due to its unknown cause and because at times the fruit can be very seriously disfigured by it. The disease deserves much more detailed investigation than it appears to have received either in Jamaica or elsewhere.

As Speckle increases in severity with the state of maturity of the fruit on the plant, care has to be taken to note the age of the bunches on which records of speckling are taken, otherwise misleading data may be obtained.

(i) **Nitrogenous fertilizer experiment:** Referring to this disease Wardlaw (1935) has stated that "it may be directly related to lack of available nitrate in the soil". An experiment was designed to compare the effect of using different nitrogenous fertilizers. Included in the experiment were also treatments with proprietary mixtures of different minor elements. The treatments were first applied to the plant crop three months after planting and were subsequently applied every three months. Unfortunately the ratoon bananas suffered so severely from blowdowns and other accidents that too much fruit was lost from which to obtain reliable data. The incidence of speckle could therefore only be assessed on the plant crop. A disease Index number for speckle was calculated along the same lines as the Index number for oil phytotoxicity. There were no differences in the amount of speckle due to the various treatments, although they produced significant differences in the growth of the plants. (Appendix Path. 9).

(ii) **Fruit bagging experiment:** In co-operation with Mr. D. K. Mason, of Metal Box Co. Ltd., experiments were carried out covering bunches in the field with different coloured polythene tubing. So many bags failed to survive the 2–3 months duration required for these experiments that incomplete records were collected.

Although there was a very slight indication of reduction of speckle due to bagging, the results were by no means convincing. As reports have been received from other countries that bagging is thought to be beneficial, these experiments are to be repeated.

E. **Fruit Storage Diseases**

In the 1956/57 Annual Report the diseases which develop on Jamaica bananas, during transport overseas, were considered to be dependent on damage caused by mishandling of the fruit before the start of the voyage to the U.K. Trials were undertaken to note the effect of more careful loading and unloading of trucks because it was thought that most of the damage occurs on the trucks, especially since the fruit is not bagged in polythene until after truckage.

In the prevailing method of handling, the fruit tends to be dragged from its position on the truck when being unloaded so that the fingers are abrased, leading later to the de-

velopment of Anthracnose, and their stalks are damaged, resulting in the all too common Santa Marta Stem End Rot. In the trials the emphasis, in more careful handling, was placed upon lifting rather than dragging the fruit from its position on the trucks.

Extra supervision was provided at the points of collection of the fruit and, more especially, at the unloading of the trucks on Port Antonio wharf prior to shipment. The fruit was collected from two areas in Portland including large and small plantations. Bulk consignments of 6-12,000 stems were tagged and despatched, starting on 19/12/57, which was before the improvement in fruit quality is usually noticeable. No extra care was taken in stowing the fruit in the ship's holds.

The reports received, on the condition of this fruit in the U.K. ripening rooms, were extremely encouraging. All the agents separately noted an outstanding improvement in the appearance of the fruit. Difficulties were later experienced in maintaining the high standard of handling originally achieved.

The work of the Assistant Plant Pathologist reported below confirms the essential need for more careful handling while, at the same time, explaining the mode of action of the organisms responsible for the resultant diseases.

VII. REPORT OF ASSISTANT PLANT PATHOLOGIST (D. S. MEREDITH)

The present report is based on a series of observations, made in the United Kingdom, on bananas arriving from Jamaica during the period September 1, 1958–February 28, 1959. In the first place it was considered desirable to investigate the most important diseases apparent on newly arrived fruit. Secondly, investigations were initiated at storage depots in order to trace the progress of disease during the ripening process: also, experiments were conducted with the causal organisms. Finally, an attempt was made to assess the evidence of handling damage to fruit during and after discharge from ships at Avonmouth and Southampton docks.

Due acknowledgment is here given to all persons who made this investigation possible: Professor H. G. H. Kearns, O.B.E., for providing laboratory facilities at the Research Station, Dept. of Agriculture and Horticulture, Long Ashton, (University of Bristol); Mr. R. W. Marsh, Assistant Director, Long Ashton Research Station. for his interest and advice; Mr. H. J. Stockley, Managing Director of Elders & Fyffes Ltd., Mr. R. G. Hurrell and many other officers of the Sales Department of that firm for their very kind co-operation in providing access to ships' holds and for granting permission for experiments to be carried out in the ripening rooms; Mr. E. H. Greaves, Managing Director, Jamaica Producers Marketing Company Ltd., for granting access to ripening rooms; D. Aliband, Research Station, Long Ashton, for taking many photographs.

A. Fruit Rotting Fungi Associated with Wastage

One important cause of waste is the development of rotting organisms on the fruit, both during transport in ships' holds and subsequently during the ripening process. In most cases, full symptoms of disease are manifest when the fruit is approaching maturity. This often results in fruit becoming unsightly and of relatively low commercial value.

Repeated observations at ports of discharge and inside ripening rooms showed that **Gloeosporium musarum** Cke. & Massee is the most frequent fruit-rot fungus on Jamaican fruit: several species of **Fusarium** were often associated with **G. musarum.** Less common were **Botryodiplodia theobromae** Pat. and **Ceratocystis (Thielaviopsis) paradoxa** (De Seynes) von Hohnel. Fungi appearing sporadically, particularly on badly mutilated fruit, include **Mucor** spp., **Penicillium** spp. and **Rhizopus** spp. **Trachysphaera fructigena** Tabor & Bunting was observed on a few occasions.

(i) Anthracnose:

(a) **Symptoms of disease on Jamaican fruit:** By inoculating immature fruit in the field Simmonds (1941) demonstrated that **G. musarum** can remain in the form of 'latent infections' (Dastur 1916) which resume activity when maturity is approached. Thus, apparently healthy green fruit may, when ripe, develop severe Anthracnose symptoms. According to Wardlaw (1935), Anthracnose develops as small, black spots on the skin which increase in size resulting in the formation of more or less isodiametric, slightly sunken lesions. At a

later stage, each lesion becomes covered with numerous salmon-coloured acervuli.

During recent years, consignments of Jamaican fruit have been seriously affected by a disease similar to Wardlaw's Anthracnose. However, unlike the isodiametric type of Anthracnose, the symptoms on Jamaican fruit are clearly visible on green, immature fruit of the Lacatan, Robusta and Gros Michel varieties (Leach, 1958). Lesions are typically lenticular with the long axis parallel to that of the finger.

The distribution and frequency of such Anthracnose lesions on recently discharged bunches of green fruit from Jamaica was investigated. For each bunch, the outer and inner fingers of the butt-end, 5th and tip-end hands were examined. (Appendix Asst. Path. 1).

Lesions occurred more frequently on outer fingers than on the less exposed inner ones. A possible explanation of this was that spores of **G. musarum** initiate infection of green fruit through wounds incurred during handling operations in Jamaica. Naturally, more exposed fingers will suffer a greater number of abrasions than less exposed ones.

The development of marked lesions was observed during the ripening process. Little increase in size occurred for the first three days at 70°F. when the fruit was still green. However, later when the fruit was turning", lesions increased in size rapidly: in one instance, an increased length of 3.6 cm. was observed after 4 days. As a result of this rapid development, appreciable quantities of fruit were unfit for marketing. It was observed that a small proportion of lesions did not increase in size and simply led to "Scarring".

(b) **Experimental infection:** A series of inoculation experiments were initiated to test the pathogenicity of **G. musarum** isolates obtained from infected fruit. In one experiment, apparently healthy, unwounded fingers were inoculated by painting on spore suspensions on to the skin surface. This was carried out at the port of discharge on fruit which was subsequently dispatched to ripening rooms. Inoculated fruit was re-examined when fully ripe, that is, after 7–9 days storage at 70°F. In the majority of samples, there was no superficial indication of infection having occurred. However, in a few, small dark spots, similar to the early stages of Anthracnose described by Wardlaw, had developed in inoculated tissues: Similar experiments carried out under laboratory conditions suggested that the fungus requires 10–13 days in order to infect healthy tissues and cause severe Anthracnose symptoms. It was concluded, therefore, that **G. musarum** is unlikely to have sufficient time to develop extensively on healthy, unwounded fruit which is infected after discharge in the U.K.

The development of the fungus in wounded tissues was investigated. Immature fruit was inoculated at the port of discharge by bruising the skin tissue and applying conidia. After ripening at 65°–70°F. for 9 days, it was found that 96 per cent of the inoculations were successful, resulting in the development of typical, but small, lenticular lesions: acervuli were present in most cases.

In other experiments, immature fruit was injured in such a manner as to simulate the types of damage occurring during the process of discharging fruit from the ship. After full maturity was attained the fruit was examined for development of **G. musarum.** In one experiment, 50 per cent of the bruised fruit developed lenticular lesions, while in another, only 5 per cent became infected. This difference was possibly related to the respective amounts of inoculum present on the fruit surface at the time of wounding. It was noted that lesions developed most frequently on fruit in which the skin was ruptured slightly and only rarely on those in which the skin remained unbroken: severely mutilated fruits did not become infected, a finding in agreement with that of Leach (1958).

A comparison of lesions present on mature fruit showed that those initiated experimentally at the port of discharge were not nearly so advanced in development as those which were already established on newly arrived fruit. There is little doubt that the proportion of disease, manifest on ripe fruit, ascribable to infection after arrival in the U.K., is usually negligible in comparison with that developing from infections already established at the time of arrival.

(c) **Latent infection:** The progress of infection by **G. musarum** has been studied by Chakravarty (1957). On germination, each conidium produces one or, more rarely, several germ tubes which elongated finally swell at the tip to produce thick-walled, spore-like bodies, or appressoria. Each appressorium develops a fine infection hypha which penetrates the host cuticle by mechanical means. The fungus remains inactive in the subcuticular region until the fruit ripens; activity is then resumed, resulting in further penetration and the development of anthracnose lesions.

An attempt was made to demonstrate the presence of latent infections on newly arrived, immature bananas of the Lacatan and Gros Michel varieties. Apparently healthy, green fingers were detached from the main stalk and surface sterilized by immersion for two minutes in 0.1% mercuric chloride in 70% alcohol. After washing in sterile water, cores of skin tissue, 1 cm. in diameter and 0.5 cm. thick, were removed by means of a sterile cork borer and maintained aseptically inside moist Petri dishes. The cores were examined after 15 days at 70°F for acervuli of **G. musarum.** In one series, the fungus developed on 85 of the 120 cores isolated, confirming the presence of latent infections.

Since appressoria of **G. musarum** have a characteristic appearance, observations were designed to detect them on immature fruit. Detached fingers were immersed in cotton blue in lacto-phenol for 2 minutes and then rinsed in water. Hand surface sections were mounted in lacto-phenol and examined under a high power objective. In many sections, appressorium-like bodies were observed on the surface of the cuticle; and were usually confined to the grooves between epidermal cells. The structures are thick-walled, dark-coloured and often irregular in outline; in most cases, a small circular hyaline area is clearly visible. Occasionally, what appeared to be the empty, germinated conidium was observed close to the appressorium-like body, and in some instances, the remains of the interconnecting germ-tube were visible. In more mature fruit, one or several of the epidermal cells immediately below the bodies had developed an orange brown discolouration. Attempts to dislodge the structure by continuous washing were unsuccessful.

The close similarity between the naturally occurring bodies and appressoria of **G. musarum** was also evident in vertical sections: in both cases, infection hyphae, which had penetrated the cuticle, were observed. It was concluded, therefore, that appressoria of **G. musarum** can be readily identified by microscopic examination, even in the absence of conidia.

In some specimens, the number of appressoria was very large. However, when the fruits were allowed to mature under aseptic conditions, only a few anthracnose lesions developed. This finding is compatible with Simmonds' (1941) suggestion that only a small proportion of latent infections resume activity in mature fruit.

Further investigation is necessary to trace the sources of inoculum of **G. musarum** in Jamaica and the time of infection of fruit.

Mature fruit was inspected in ripening rooms in order to assess the relative importance of Anthracnose developing from latent infection as a source of waste. It is the usual practice of wholesalers to despatch to retailers fruit which has just developed an even yellow skin colouration. It was observed that the type of Anthracnose lesion described by Wardlaw was very insignificant on such fruit, and did not contribute appreciably to the total quantity of waste. Only on very mature fruit, such as was seen at various retailers, was this type of lesion observed to any significant extent. It was concluded that latent infections will account for a negligible amount of waste if fruit is ripened and marketed with the minimum of delay.

(ii) **Santa Marta Stem-End Rot (S.M.S.E.R.):** This form of rot has been described by Wardlaw (1935) as 'finger-stalk rot'. Individual finger stalks which have suffered injury frequently become infected by **G. musarum** and other fungi. Injury is usually in the form of a transverse creasing or notching, due to the finger being twisted or pressed inwards or outwards during handling. Fruit of the Lacatan variety is, in general, more prone to such injury than is that of the Gros Michel variety. This is probably a result of the contrasting bunch habits of the two varieties, the former being less compact and more openhanded than the latter. Also, finger-stalks of the Lacatan variety are generally longer and of smaller diameter than those of Gros Michel fruit so that the mechanical resistance to bending is lower in the former. In both varieties, the incidence of S.M.S.E.R. is highest in the tip and butt hands and lowest in intermediate hands.

The degree of care taken while handling fruit prior to, and during loading will obviously be reflected in the condition of the fruit on arrival at the port of discharge. Several consignments provided ample evidence that fruit had been subjected to extremely rough handling. During ripening, the organisms causing rot spread rapidly through the finger-stalk tissues with the result that individual fingers fall from the main stalk. S.M.S.E.R. was often at an advanced stage of development on newly arrived fruit, so that large numbers of fingers became detached during discharge. The presence of even a small rotted area in a finger stalk greatly reduces the mechanical resistance to breakage.

Surveys were carried out at the ports of discharge and in ripening rooms to assess the

frequency with which different fungi were associated with S.M.S.E.R. In one survey, **G. musarum** was present in 88 per cent of infected finger-stalks and **Fusarium** spp. in 38 per cent. Although **T. paradoxa** occasionally causes S.M.S.E.R., it is not considered to be of commercial importance on Jamaican bananas.

Observations and experiments were designed to assess the proportion of S.M.S.E.R., apparent after ripening, which was initiated during discharge from the ship, and during subsequent handling. Firstly, bunches were removed from conveyor belts at the port of discharge and examined for already established S.M.S.E.R. and for finger-stalk damage incurred during discharge.

The proportion of discharge damage was markedly less than that of already established S.M.S.E.R. (Appendix Asst. Path. 2). On the basis of number of fingers affected, the former proportion was almost negligible by comparison with the latter. In extreme cases, every finger-stalk of a hand was affected by S.M.S.E.R. on arrival, and this resulted in a high proportion of fruit being rejected at the quayside.

Further observations provided information about the amount of injury which may occur between the time of removal of fruit from conveyor belts and the time of hanging in ripening rooms. Labelled fruit was examined firstly at the conveyor belt stage and again in the ripening rooms. As in other surveys, the proportion of discharge damage was relatively low in comparison with that of S.M.S.E.R.: however, there was a surprising increase after transportation to the ripening rooms. (Appendix Asst. Path. 3). This might have occurred at one or all of the following stages: loading by dockers into railway trucks, movement of fruit in transit, unloading truck and loading lorry, transfer from lorry to ripening rooms. In addition to the damage recorded above, the main-stalks of two bunches were broken.

Experiments were designed to obtain information about the rate of spread of rotting fungi following initial infection after discharge. Fruit which was free from S.M.S.E.R. was selected, and the fingers flexed in such a manner that the stalks were creased: in most cases, the skin tissues were ruptured. The fruit was despatched in the normal manner to ripening rooms and examined at maturity for any development of S.M.S.E.R. In one experiment all damaged finger-stalks developed rot (caused by **G. musarum**); however, rot was still in an early stage and there was no finger dropping. In other experiments, a smaller percentage of injured stalks developed S.M.S.E.R. and, again, rotting was not sufficiently extensive to cause finger drop. Inoculation experiments were carried out by applying conidia of **G. musarum** to finger-stalks which had been injured in the manner already described. After ripening at 62°–75°F. for 8 days, it was found that all inoculations were successful, but rotting of finger-stalks was not extensive. From these results it was concluded that S.M.S.E.R. caused by **G. musarum** and initiated after arrival in the United Kingdom, is unlikely to develop extensively before the termination of ripening. It would appear that the time interval is normally too short.

Since **T. paradoxa** is occasionally associated with S.M.S.E.R., it was considered desirable to investigate the effect of inoculating fruit at the time of discharge. The results confirmed Wardlaw's (1935) finding that **T. paradoxa** is a rapid growing organism. It is possible, therefore, that the fungus may cause extensive S.M.S.E.R. following injury during or after discharge; but the fungus is so infrequent on Jamaican fruit that it is considered to be insignificant as a cause of waste.

(iii) **Main-Stalk Rot:** This is the disease frequently called Soft Stem End Rot (S.S.E.R.) in the trade. Although Main-Stalk Rot can be detected in most consignments, it would appear that treating severed stalk ends with polyethylene polysulphide (PEPS) shortly after harvesting is reasonably effective in excluding stalk-rot fungi. Observations in ships' holds showed that butt-end rot is more frequent and extensive than tip-end rot, probably because vertically stowed bunches rest on the butt-end. The weight of the bunch and of those stowed above result in the butt being under a considerable pressure so that it often becomes bruised or split, allowing the ingress of rotting organisms.

The development of main-stalk rot was followed throughout the ripening process. Fungi most frequently associated with rot were **G. musarum** and **Fusarium** spp., with **T. paradoxa** being of minor importance. At the relatively high temperature inside ripening rooms these fungi spread rapidly through stalk tissues. Rot frequently invaded the cushion of the small lowermost hand, and in extreme cases, entered the finger-stalks. These activities made it

difficult to handle the ripe fruit without finger-drop occurring. In the case of butt-rot, it was rare for the large upper hand to be invaded within the interval allowed for ripening, because of the relatively great length of a stem which the fungus had to traverse. Exceptions to this were found on bunches whose stalks had been initialled by growers shortly after harvesting. Such identification marks were invariably scratched on the main-stalk and were rarely treated with PEPS. These wounds often allowed decay fungi to invade the stalk at a point not far removed from the large hand.

Main-stalk rot may also originate in an intermediate position on the stalk, commonly in the form of local lesions in, or near, the cushions. This often results from hands being subjected to a blow, so that tissues in the cushion or main-stalk are subjected to mechanical strain. Such bruised tissues are readily infected by the above-named fungi.

(iv) **A note on Trachysphaera fructigena on Jamaican bananas: Trachysphaera fructigena** was first described by Tabor and Bunting (1923), who observed the organism causing mealy-pod disease of cocoa and coffee in the Gold Coast. During recent years the fungus has been recorded on bananas growing in West Africa. However, there appears to be no record of the fungus on these hosts growing in the West Indies.

Although the fungus was often observed at English ports on newly arrived Gros Michel fruit from the British Cameroons and Fernando Po, it was not found there on Jamaican Gros Michel or Lacatan bananas. However, on three occasions. a few infected Lacatan fruits were discovered inside ripening rooms after 7–9 days ripening. Symptoms of disease were as advanced as those seen on mature Cameroon fruit, which was already infected on arrival in the U.K.

Since it was known that the rooms which contained infected Jamaican fruit formerly contained severely infected Cameroon fruit, it seemed reasonable to suspect this as a possible source of inoculum. Conveyor belts, railway trucks or lorries on which fruit from both regions is transported were also considered suspect. Further observations and experiments were initiated, therefore, in order to investigate the infection biology of **T. fructigena.**

Experimental inoculations showed that the fungus readily infects wounded immature fruit, often resulting in the appearance of advanced symptoms after 5–7 days storage at 65°–70°F. Attempts to infect healthy unwounded fruit were unsuccessful. It is possible, therefore, that infection of Jamaican fruit by **T. fructigena** was initiated after discharge, by spores from Cameroon fruit, and ripening rooms would appear to be the most likely source of such spores.

Although the quantity of diseased Jamaican fruit observed so far is commercially insignificant, it is desirable that the risk of such infection should be reduced. It is normal practice to wash out ripening rooms before introducing a fresh consignment of fruit. It is suggested that rooms formerly containing severely infected fruit should be disinfected more thoroughly. Similar considerations apply to chains or ropes by which stems are suspended. Also, all infected fruit should be removed as soon as it becomes evident, in order to minimise the amount of inoculum which may accumulate inside the room.

VIII. REFERENCES

1912 — U.S. Dept. of Agric. Bur. Pl. Indust. Bull. 230.
1915 — Bull. Dept. Agric. Jamaica. 2. 316.
1916 — Agric. J. India, XI, 142.
1923 — Ann. Bot. Lond. XXXVII, 153.
1927 — Porto Rico Agr. Expt. Sta. Rept. of Director.
1932 — Bull.45. United Fruit Co. Res. Dept.
1935 — "Diseases of the Banana" — MacMillan & Co.
1941 — Proc. Roy. Soc. Qd., LII, 10, 92.
1946 — Banana Leaf Spot **(Mycosphaerella musicola).** Dept. Agric. Jamaica.
1949 — "Diseases of Plants in Jamaica", New Series Bull. 32, Dept. of Agric. Jamaica.
1950 — "Economic crops. Vol. 1. Bananas" — Interscience Publ. Ltd., London.
1951 — U.S. Dept. Agric. Soil Conserv. Serv.
1955 — Emp. Journ. Expt. Agric. XXIII. 11.
1957 — Trans. Brit. Mycol. Soc. XL. 337.
1958 — Ann. Rep. Banana Board Res. Dept. 1956–7.

IX. PUBLICATIONS

E. A. TAI: "Timing the Lacatan Banana Crop", Ban. Board. Res. Dept. Jam. Occ. Bull. 1. 1958.

R. LEACH: "Blackhead toppling disease of bananas", Nature CLXXXI. 204, 1958.

R. LEACH: "Controlling banana borer", Journ. Jam. Agric. Soc. LXII. 204, 1958.

(External Author):

R. E. OSBORNE: "Breeding the immune banana", Ban. Board. Res. Dept. Jam. Occ. Bull. 2. 1958.

APPENDIX

Phys. 1 **TIMING OF CROP PRODUCTION**

Lay out — 3 Randomized blocks. 5 Treatments. Plot size 50 mats.

Treatments

(a) Standard estate practice of selecting a follower based on Gros Michel experience.

(b) Selection of the first sucker to emerge as follower.

(c) Selection of a sucker which it is estimated should follow the parent at approximately a year.

(d) No pruning of suckers until after the parent has shot at which time selection of the follower is made.

(e) Pruning away all suckers as they appear until the parent has shot; after that the first sucker to emerge is selected as follower.

Observation	Treatment					
	(a)	(b)	(c)	(d)	(e)	Mean
Suckers produced per mat						
(1) Plants	7.1	6.2	6.7	6.6	6.1	6.5
(2) Ist ratoons	2.5	3.5	2.2	2.5	2.3	
Time from planting to shooting (weeks), plants	46.4	45.3	45.4	46.2	46.6	45.8
% Population from which fruit was reaped ..						
(1) Plants	65.4	64.0	64.0	69.4	60.6	64.7
(2) Ist ratoons	53.4	57.4	52.6	59.4	43.4	53.2

Phys. 2. TIMING OF CROP PRODUCTION

Summary of observations on sundry plots. Plot size 9–30 mats.

"Plant" crop		Months to shooting		
Location	Planted	Follower Selected		
		Apr.–Sept.	Oct.–Mar.	Local Practice
St. Catherine plain	Aug. 1956	9.0	9.5	8.8
St. Catherine hill	Mar. 1957	18.4	17.7	18.1
St. Mary plain	May 1957	10.4	10.4	10.8
St. Thomas plain	Aug. 1957	7.5	–	7.7
Vere plain	Oct. 1957	10.7	10.8	10.8

Phys. 3 TIMING OF CROP PRODUCTION

Summary of observations on growing period of first ratoons.

Months to shooting after "plant" shot

Location	Followers Selected		
	April–Sept.	Oct.–March	Local Practice
St. Thomas ..	6.0	–	6.1
St. Mary ..	6.5	7.2	7.2

Phys. 4. OPENHANDEDNESS

Lay out. Unreplicated. Control paired with each of 4 treatments.

Treatments (Pruning Season)
(a) February — dormant season
(b) April — spring, start of active growth.
(c) July — summer, most active growth.
(d) October — fall, declining growth.

Sub-Treatments Heights of plants
1. Full grown
2. ¾ „
3. ½ „
4. ¼ „

Time of Root Pruning

Stage of Growth	February		April		July		October	
at Root Pruning.	Pruned	Control	Pruned	Control	Pruned	Control	Pruned	Control
Openhandedness								
Full Grown	–	–	–	–	1.5	2.1	3.0	3.0
¾ „	2.3	2.8	1.6	2.2	3.0	3.0	2.0	3.0
½ „	2.3	2.2	3.0	2.8	3.0	3.0	3.0	–
¼ „	2.5	3.0	2.5	3.0	3.0	3.0	–	–
Weekly Height Increase in inches								
¾ Grown	1.82	1.76	–	–	2.36	2.00	–	–
½ „	2.67	2.86	1.98	2.19	2.74	3.24	–	–
¼ „	2.90	3.26	2.98	2.96	2.60	3.23	–	–
Weekly Production of New Leaves								
¾ Grown	0.6	0.8	–	–	0.6	0.6	–	–
½ „	0.7	0.7	0.6	0.6	0.5	0.6	–	–
¼ „	0.6	0.6	0.6	0.6	0.6	0.6	–	–

Grades of openhandedness.
0 (None)
1 (Single hand open)
2 (Not more than two hands open on one side of stem)
3 (More than two hands open on one side of stem).

Phys. 5. **OPENHANDEDNESS**

Lay out. 5 Randomized Blocks. 4 Treatments time of applying fertilizer. Plot size. 6 mats.

Treatments

All treatments supplied a total of 2¼ lb. of Sulphate of Ammonia in one year divided into monthly applications.

Applications

(a) Every month.
(b) Omitted between 4 months old and bulling.
(c) Omitted after bulling for one month only.
(d) Omitted altogether after bulling.

Crop	Openhandedness in treatments			
	a	b	c	d
Plant	2.5	2.1	2.2	1.8
Ratoon	3.0	2.0	1.5	1.8

Phys. 6. **PREMATURE YELLOWING — WESTMORELAND**

Lay out. 4 Randomized blocks, young bananas. 5 Treatments. Plot size — 8 mats, subplots — 4 mats.

Treatments

1. No fertilizer — control
2. Sulphate of Ammonia, 6 cwts/acre/annum
3. Nitrate of Soda, 7½ cwts/acre/annum
4. Urea 2¾ cwts/acre/annum
5. Granumix C. 6 cwts/acre/annum

Sub-treatments

(a) No potash
(b) Muriate of potash, 3 cwts/acre/annum

Treatment	Incidence of Premature Yellowing	
	No additional Potash	Additional Potash
Control	0.31	0.17
Sulphate of Ammonia	0.36	0.25
Nitrate of Soda	0.30	0.14
Urea	0.47	0.16
Granumix C	0.28	0.20
Mean = 0.27 ± 0.04		

Phys. 7. **PREMATURE YELLOWING — BOG WALK & ST. THOMAS**

Lay out (i) Bog Walk — 6 Randomized blocks 3 Treatments, 3 Sub-treatments. Subplot size 6 mats.
(ii) St. Thomas — 8 Randomized blocks 3 Treatments, 3 Sub-treatments. Subplot size 9 mats.

Treatments

A.	Sulphate of Ammonia	6 cwt/acre/annum	6/cwt/acre/annum
U.	Urea	2½ cwt/acre/annum	Muriate of potash
S.	Nitrate of Soda	7½ cwt/acre/annum	1. In 2 applications
			2. In 4 „
			3. In 8 „

Frequency of potash applications totalling

In effect all mats received approximately the same amounts of NPK each year.

Incidence of Premature Yellowing (St. Thomas)

Treatment	Sub-treatment			Mean
	1	2	3	
A	0.33	0.21	0.22	0.26
U	0.29	0.28	0.26	0.28
S	0.17	0.26	0.21	0.21
Mean	0.26	0.25	0.23	0.25 ± 0.07

Chem. 1a. **COMPARATIVE SOIL INVESTIGATIONS**

Soil Analyses

Field	Depth in inches	% Sand	% Conv. Clay	% Conv. Silt	% Finer Clay	pH	Avail. K_2O p.p.m.	Avail. P_2O_5 p.p.m.	NaCl p.p.m.
A	0 – 9	44.8	28.0	27.2	24.8	8.0	207	494	92
	9 – 18	42.8	30.0	27.2	26.8	8.2	212	442	100
	18 – 27	42.8	30.0	27.2	26.8				75
	27 – 36	40.8	31.0	28.2	26.8				67
B	0 – 9	38.8	34.4	26.8	30.8	8.2	318	494	142
	9 – 18	44.8	30.0	25.2	27.2	8.0	231	514	92
	18 – 27	48.8	26.0	25.2	23.8				58
	27 – 36	46.8	25.0	28.2	22.8				83

Mechanical Analysis by the Hydrometer Method; pH by the Glass Electrode; Available Phosphate by the Truog Method; Available Potash using N/2 Acetic acid extract and Sodium Chloride by the Electrometric Titration Method.

Chem. 1b.

Lay out. Single 6 ft. pits sampled — unreplicated.
St. Catherine. Good (A) and Poor (B) yielding banana fields.
% Total Pore Space

Field	Depth in inches	December	January	February	March	April
A	½– 3½	43	41	66	37	40
	6½– 9½	46	37	38	36	32
	12½–15½	46	45	32	41	35
	18½–21½	46	45	33	43	35
	24½–27½	47	47	34	46	43
	36½–39½	50	44	39	49	x
	48½–51½	52	46	35	50	x
	60½–63½	49	47	36	44	x
B	½– 3½	45	37	41	48	42
	6½– 9½	42	37	33	47	26
	12½–15½	39	32	34	34	32
	18½–21½	38	30	38	36	27
	24½–27½	(W.T.)	34	35	(W.T.)	34

(W.T.) = Water Table x = Attempted but soil too sandy.

Chem. 1c. Lay out — 4 Random pits, 18 inches deep, in each field per month.

Mean% Total Pore Space

(a) Depth (inches)

Field	½"–3½"	6½"–9½"	12½"–15½"	Field Mean
A	48.4	39.3	38.8	42.2
B	45.6	39.7	41.8	42.4

No Significant Difference between Fields.

(b) Months

May	June	July	Aug.	Sept.	Oct.
38.6	40.5	39.9	44.6	43.5	46.4

Sig. Diff. P,0.05 = 3.2; P,0.01 = 5.0
Coeff.Var = 11.7% G.M.

Chem. 2. **SURVEY OF BANANA FIELDS AND SOILS**

Properties Surveyed

Property	Owner
Frontier Estate	Mr. C. L. Clemetson
Oxford	„ Ian Millar
Trinity	„ R. C. Braham
White Hall	„ Walter DeLisser
Good Hope Farm	„ R. Coy
Brimmer Hall	Major D. J. Vaughan
Liberton	Capt. R. B. Daly
Llanrumney	Mr. P. J. Parachini
Ballards Valley	Messrs. O. Davies & P. Girling
Part of Esher	Mr. S. Coy
Part of Moore Hall	Dr. S. Martin
Part of Esher	Mr. A. F. Villiers
Quebec	Mr. I. S. Magnus
Part of Heywood Hall	„ G. Champagnie
Cove	„ H. Champagnie
Agualta Vale Estates	Sir Harold Mitchell
Grays Inn	Mr. Charles Pringle
Water Valley	Sir Harold Mitchell
Rosend	Mr. B. G. Amritt
Part of Albany	Mr. Vesta Heywood
Wentworth	Union Real Estate Company

APPENDIX
LEAF ANALYSIS

Anal. 1.

Figures quoted are averages of five determinations each.
Percentages in d.m.

	N		P_2O_5		K_2O		CaO		MgO	
	Half	Middle	Half	Middle	Half	Middle	Half	Middle	Half	Middle
Leaf No. 1	2.90	2.86	0.56	0.56	4.10	4.03	1.10	1.02	0.64	0.64
Leaf No. 5	3.00	2.88	0.48	0.49	3.79	3.79	1.84	1.74	0.73	0.80
Coeff. Var.	3.96		3.96		3.95		41.43		42.22	
Sig. Diff. (P,0.05)	0.49		0.02		0.15		0.53		0.26	

Note: As the C.V. for Calcium and Magnesium were so high, little reliance can be placed on the figures unless the experiment is repeated with more replications.

TENDERNESS OF FRUIT IN RELATION TO POTASH CONTENT

Anal. 2.

Potash in banana skins
Potash (K_2O in d.m.) in Green Fruit Skins

Bowden Area	**St. Catherine**
Range 6.8 – 10.0	7.0 – 10.3
Mean 8.2	8.4

APPENDIX

Agr. 1. **FERTILIZER COMPARISONS — St. Catherine**

Lay out 5 x 5 Latin square. Plot size 24 mats.

Treatments (Fertilizers applied in 3 equal doses per annum)

A. Untreated
B. Humber fish, 100.8 ozs/plant/annum. Equivalent N to standard estate practice of 24 ozs. Sulphate of Ammonia.
C. NPK using Sulphate of Ammonia for N. Equivalent to Treatment B in respect of major elements.
D. NPK using Urea (46%) for N. Otherwise same as Treatment C.
E. Humber fish, 46.3 oz/plant/annum. Equivalent in cost to Treatment C.

Fertilizer	No. Hands per stem	Wt/hand (lb.)	Count bunch acre	Cost Fertilizer annum.
A	6.60	4.34	242.8	Nil
B	6.88	4.40	282.7	£49. 1. 6
C	7.05	4.37	309.2	£22. 0. 5
D	6.93	4.32	293.5	£21. 7. 10
E	6.86	4.28	281.5	£22. 13. 0
Sign. Diff. P,0.05	0.18	0.22	34.5	
P,0.01	0.25	–	48.5	
Coeff. Var. (% GM)	1.9	3.7		

Agr. 2. **FERTILIZER COMPARISONS — St. Mary**

Lay out 6 Randomized blocks. Plot size 6 mats.

(a) **Yield**

Treatments (Fertilizers applied per annum in 3 equal doses.)

A. Humber Fish — 32 ozs.
B. Albatros (12:15:18) — 16 ozs.
C. NPK/Urea — 21.9 ozs.
D. NPK/Sulphate of Ammonia — 26 ozs.
(a) E. None (Control)

Fertilizer	No. Hands per stem*	No. Hands per stem (12 mths.)	Wt. per stem (lb.)	Wt. per stem in 12 mths. (lb.)	Counts per acre/annum
A	6.10	5.94	23.4	22.4	125.4
B	6.03	5.74	23.0	21.4	102.2
C	6.12	5.89	24.8	23.8	117.9
D	6.11	5.88	22.8	21.9	108.1
E	5.76	5.27	21.9	20.2	70.8
Sign. Diff. (P,0.05)		.75		5.7	32.9
Coeff. Var. (% G.M.)		13.2		21.9	26.1

* Poor fruit, below 6 hands, included.

(b) **Costs**

Fertilizer acre/annum		Application acre/annum	**Returns** Gross	Net acre/annum
Humber Fish	£12.15	£0.30	£56.70	£44.25
Albatros	£ 6.99	£0.30	£56.70	£49.41
NPK/Urea	£ 5.8	£0.30	£56.70	£50.80
NPK/Sulphate of ammonia	£ 6.2	£0.30	£56.70	£50.20
Control	—	—	£35.4	£35.4

Cash per acre
(7% added for interest on fertilizer money)

	Risk	**Profit**
NPK/Urea	£ 6.53	£15.4
NPK/Sulphate of Ammonia	£ 6.95	£14.8
Albatros	£ 7.80	£14.01
Humber Fish	£13.32	£ 8.85

Agr. 3. **NPK TRIALS — (a) 3^3 FACTORIAL EXPERIMENT — Portland**

Lay out 3 blocks each in different sites and each of 9 plots

Treatments
(N) Sulphate of Ammonia) all at
(P) Single Superphosphate) 0, ¼ lb., ½ lb.
(K) Muriate of Potash) per mat.

	N_0	N_1	N_2	P_0	P_1	P_2	K_0	K_1	K_2	Sign. Diff. P,0.1	Sign. Diff. P,0.05	Coeff. Var. (% G.M.)
No. hands per stem	7.10	6.96	6.91	6.92	7.04	7.01	6.74	7.10	7.12	.33	.40	5.65
Wt./No. Hands	4.36	4.29	4.22	4.29	4.23	4.36	4.08	4.35	4.4	.25	.31	7.11

Agr. 4. **NPK TRIALS — (b) 3^3 FACTORIAL EXPERIMENT — Christiana Area**

(Treatments as in Appendix Agr. 3.)

	N_0	N_1	N_2	P_0	P_1	P_2	K_0	K_1	K_2
No. hands per stem	6.95	7.34	7.40	6.92	7.24	7.52	7.23	7.59	6.86
Av. Wt./Hand (lb.)	4.96	5.25	5.21	4.93	5.30	5.18	5.04	5.45	4.92

No Analysis

Agr. 5. **NPK TRIALS — (c) 3^3 FACTORIAL EXPERIMENT — St. Ann**

(Treatments as in Appendix Agr. 3.)

	N_0	N_1	N_2	P_0	P_1	P_2	K_0	K_1	K_2
Av. no months to reaping	12.8	12.7	12.7	12.8	12.7	12.7	12.7	12.7	12.8
No. Hands per stem	7.26	7.12	7.13	7.11	7.27	7.13	7.16	7.18	7.17
Av. Wt./stem (lbs.)	34.3	33.5	32.6	33.4	34.4	32.7	33.3	33.4	33.7

No Significant Differences

Agr. 6. **NPK TRIALS — (d) 3^2 FACTORIAL EXPERIMENT**

Lay out 3 x 2 x 2 Factorial Experiment at 7 different sites.
Duration — plant crop & 4 ratoons. **Plot size 6 or 8.**

Treatments: N. Ammonium Sulphate, 0, ¼ & ½ lb.
P. Single Superphosphate, 0 & ½ lb.
K. Muriate of Potash, 0 & ½ lb.

Av. No. Hands per stem

Site	N_0	N_1	N_2	P_0	P_1	K_0	K_1
I	7.20	7.40	6.87	7.25	7.06	6.94	7.37
II	6.40	6.38	6.51	6.23	6.63	6.32	6.54
III	7.08	6.79	6.65	6.82	6.86	7.07	6.61
IV	6.52	6.40	6.71	6.53	6.58	6.51	6.60
V	7.98	8.44	8.49	8.17	8.43	8.19	8.41
VI	6.49	7.15	5.99	6.21	6.85	6.15	6.93
VII	7.48	7.74	7.44	7.40	7.71	7.34	7.77

Sign. Diff. P,0.1 for N = 0.62, for P & K = 0.51 Coeff. Var.
at each site P,0.05 „ N = 0.75 for P & K = 0.61 7.2% G.M.

Av. Wt./hand (lb.)

Site	N_0	N_1	N_2	P_0	P_1	K_0	K_1
I	4.83	4.77	4.50	4.78	4.62	4.53	4.88
II	3.35	3.52	3.37	3.24	3.60	3.24	3.60
III	4.57	4.49	4.23	4.40	4.69	4.81	4.32
IV	4.46	4.45	4.58	4.61	4.38	4.34	4.64
V	4.99	5.04	5.12	5.00	5.10	5.03	5.07
VI	4.15	4.38	3.82	3.86	4.38	3.90	4.34
VII	4.99	5.22	5.13	5.10	5.12	4.81	5.41

Sign. Diff, P,0.1 for N = 0.42, for P & K = 0.34 Coeff. Var.
at each P,0.05 „ N = 0.50, for P & K = 0.41 7.9% G.M.
site P,0.01 „ N = 0.60, for P & K = 0.55

Agr. 7. **DEFOLIATION EXPERIMENT — St. Catherine Plains.**

Lay out 5 Randomized blocks, 5 treatments, 4 plants per plot.

Treatments Defoliation after	Av. Ht. of Plant at start of Expt. (inches)	Av. No. days to Shooting	Grade (No. Hands)
3½ months	28.0	323.1	7.10
5 „	27.8	317.2	6.30
6½ „	29.2	289.4	6.30
8 „	29.2	292.8	6.85
never (control)	27.8	288.3	7.20
Sign. Diff.		P.05 = 11.8 P.01 = 16.4	P.05 = .59 P.01 = .82
Coeff. Var. (% G.M.)		2.9	6.6

Agr. 8. **SUCKER TIMING OBSERVATION**

	60% of Plants in Plot	80% of Plants in Plot
mean altitude (x)	659	751.8
„ months to shooting (y)	18.4	19.5
correlation coeff.	.7649xxx	.7212xxx
regression „	.0036	.0035
't' on „ „	8.017xxx	2.05x

x = P<0.05, xxx = P<.001

Agr. 9. **RELATIONSHIP BETWEEN HEIGHT AT SHOOTING AV. GIRTH AND NO. HANDS AT DIFFERENT SITES**

Av. Height at Shooting.

	Estates			
No. Hands	A	B	C	D
5	85.5	101.0	86.2	126.7
6	99.3	101.3	97.9	126.0
7	111.8	111.1	109.2	139.8
8	122.1	127.1	122.6	153.7
9	153.4	139.5	131.8	164.0

Av. Girth

	Estates			
No. Hands	A	B	C	D
5	5.84	5.69	5.03	6.42
6	6.66	5.76	5.78	6.78
7	7.17	6.28	6.30	7.39
8	7.83	7.27	7.13	8.34
9	8.83	8.00	7.60	8.67

Path. 1. **OIL SPRAYING EXPERIMENTS**

(a) Comparison between four new spray oils screened by one Oil Company

Lay out — 4 Randomized Blocks (estates). Plot size approx. 1 acre.

	Av. % Area, of first eight leaves, Spotted	Phytotoxicity (Flecking) INDEX NO.
Oil A	1.5	1.77
Oil B	2.2	1.03
Oil C	1.6	1.10
Oil D	2.2	1.50
Sig. Diff.	—	0.59 (P,0.05)
Coeff. Var.	—	22.0%

OIL SPRAYING EXPERIMENTS

(b) Comparative trial between new spray oils marketed by three different Oil Companies

3 Randomized Blocks. 3 Treatments. Plots 1-2 acres.
Spraying Trial commenced July 1958.

		LEAF SPOT CONTROL AV. % AREA OF LEAVES SPOTTED						PHYTOTOXICITY					
		Start 5th-8th leaves Sept. 1958.			End 4th-10th leaves February 1959.			Flecking			Discolouration		
	OIL	A.	B.	C.	A.	B.	C.	A.	B.	C.	A.	B.	C.
ESTATE	I	2.48	4.68	1.30	2.16	0.60	1.96	1.47	1.69	1.39	1.80	1.57	1.19
	II	6.93	9.85	3.68	1.97	0.57	1.41	1.43	1.70	1.59	1.68	1.38	1.68
	III	7.65	3.80	5.93	13.70	3.59	4.64	1.48	0.89	1.05	0.97	0.74	0.97
	Mean	5.69	6.11	3.63	5.94	1.58	2.67	1.46	1.43	1.34	1.48	1.23	1.28

Path. 3. **MIST SPRAYING EXPERIMENTS WITH WATER MISCIBLE FUNGICIDES**

Lay out. 3 Randomized Blocks. Plot approx. 1 acre.

% Area, of Nine Leaves, spotted

Spray Treatment	Rate of application Per acre	Start Estate			End Estate		
		I	II	III	I	II	III
Copper oxychloride (A)	6 lb./4 gall.	7.5	3.9	1.0	2.4	3.4	0.9
Copper oxychloride (B)	6 lb./4 gall.	12.6	10.0	0.9	5.2	3.2	0.8
Cuprous oxide	4 lb./4 gall.	11.9	4.5	1.5	3.6	1.0	0.6
Bordeaux mixture	2:2:4 + Agral	6.8	21.1	1.6	27.3	5.6	1.2

Path. 4. **BORER SURVEY**

15 Traps in one field on each Estate.

Parish	Under 1 borer per trap	No. of Fields with 1-2 borers per trap	Over 2 borers per trap
Christiana	7	–	–
Portland	2	5	2
St. Thomas	5	4	1
St. James	2	6	4
Hanover	2	3	3
St. Elizabeth	–	1	1
Westmoreland		3	–
St. Mary	1	3	8
Totals	19	25	19
% of Grand Total	30.2	39.6	30.2

COMPARATIVE INSECTICIDE TRIALS

Unreplicated. Plot ½ acre. 10 Borer traps per plot.

INSECTICIDE TREATMENT	Before Treatment. September	Av. No. Borers per trap After Treatment. October 11.19.25.	November 1.8.16.	December 2.14.27.	January 10.17.25
None (Control)	1.6	1.4	1.2	0.7	1.5
Cosmopolicide 109.	1.5	1.1	0.7	0.5	1.2
BHC. Gamma Isomer	2.8	1.7	1.2	1.0	1.2
Dieldrin	2.6	0.3	0.0	0.0	0.3

Cosmopolicide 109 applied in water to cut surface of trap.
BHC, dusted on to cut surface of trap.
Dieldrin watered on to soil around banana mat.

Path. 6a.

EFFECT OF BORER CONTROL ON GROWTH OF BANANA PLANTS.

Lay out. 2 Randomized blocks. Plot 1 acre. Ratoon bananas.

Insecticide treatment:

A. Dieldrin, 50% W.P. (4 lb.) + Gypsum (96 lb.), at 4 ozs. per mat, once only (2 lb. active ingredient per acre)

B. Dieldrin, 50% W.P. in artificial fertilizer, at 2 lb. active ingredient per acre once only in first year, divided between 4 applications in second year.

C. None (Control).

Results of insecticide treatments.

		No. Borers per trap.		
	Date:	**19/2/57**	**10/1/58**	**15/9/58**
Treatments	A.	0.02	0.00	0.10
	B.	0.01	0.07	0.00
	C.	2.13	1.23	2.17

6b.

(Note. I = 1st shot plant in mat, II = 2nd shot plant in same mat)

Borer Treatment	No. Mats	Banana Av. Ht. (inches) I	Av. Ht. (inches) II	Av. Grade (No. Hands) I	Av. Grade (No. Hands) II	Correlation coefficient (r) Ht. I : II	Ht. Gr. I : II	Ht. Gr. I : I	Gr. II : II	No. Mats	% No. mats yielding, in 21 months, 1 bunch	2 bunches	3 bunches
A.	48	140	146	8.3	7.9	0.75	0.74	0.81	0.64	123	22.8	66.7	10.5
B.	53	143	147	8.0	7.7	0.79	0.76	0.88	0.50	123	24.4	72.4	3.2
C.	75	147	150	8.0	7.5	0.87	0.53	0.58	0.67	132	13.7	81.7	4.6

6c.

Av. incremental growth, inches per month, of different sized followers at different times of the year.

Height	Under 12"	13–24"	25–36"	37–48"	49–60"	61–72"	Av.
Feb. 19–Apr. 16, 1957	1.8	3.0	2.9	3.9	3.8	4.2	3.3
Apr. 16–June 28, 1957	6.7	9.6	12.5	12.8	13.9	12.9	11.4
June 28–Sept. 24, 1957	4.5	6.7	7.6	9.7	8.9	9.9	7.9
Sept. 24–Jan. 10, 1958	2.2	3.9	5.3	6.6	6.7	7.4	5.5
Jan. 10–Mar. 19, 1958	1.7	1.9	2.6	3.2	2.9	2.9	2.5
Mar. 19–June 13, 1958	5.4	7.1	8.3	7.0	8.9	6.1	7.1
June 13–Sept. 8, 1958	2.2	5.4	6.8	5.4	10.9	11.2	7.5
Sept. 8–Nov. 19, 1958	2.9	4.0	5.7	5.5	9.0	7.1	5.7

Av. incremental growth of all followers (inches per month)

	1957	1958
1st Quarter	3.3	2.5
2nd „	11.4	7.1
3rd „	7.9	7.5
4th „	5.5	5.7

6d.

Pooled growth records.

(Note. I = 1st shot plant in mat, II = 2nd shot plant in same mat)

Plants grouped according to height of I	Av. Ht. Shot I	Av. Ht. Shot II	No. Suckers under 12" on 19/2/57 = 51 Av. Grade (No. Hands) I	Av. Grade (No. Hands) II	% shot in 13–15 months	% shot in 16–18 months	% shot in 19–21 months	Total
(a) over 13 ft.	171	169	9.2	8.5	5.0	35.0	60.0	100.0
(b) 10–13 ft.	154	150	8.4	8.1	9.1	40.9	50.0	100.0
(c) under 10 ft.	109	121	6.5	6.4	0.0	22.2	77.8	100.0

Plants grouped according to relative height of follower to parent (I)		Av. Ht. Shot 1	Av. Ht. Shot II	Av. Grade (No. Hands) I	Av. Grade (No. Hands) II
	(i) over ½	140	148	7.9	7.7
	(ii) under ½	142	146	8.1	7.6

Path. 7a

USE OF NEMATOCIDES AT PLANTING TIME

Unreplicated. 10 Plants per treatment.

TREATMENTS

	Nemagon							Parathion		Vapam				None
	75% Emulsifiable Concentrate						Gran-	Per Cent		Per Cent				(Control)
	1/3	1/6	1/12	1/25	1/50	1/100	ules	1.0	0.5	1.0	0.5	0.1	0.05	
Disease Index No.	–	–	0.3	5.0	9.5	2.2	3.5	6.7	3.6	20.0	29.8	22.8	17.4	28.6
Av. % Roots diseased	–	–	16.7	12.4	20.1	7.2	5.9	14.9	7.2	40.3	47.6	48.8	43.0	49.6

Path. 7b.

TREATMENT OF BANANA HEADS AT TIME OF PLANTING

4 Randomized blocks. 5 Treatments. No. plants per plot = 192. Planted 19/7/58.

Treatment of banana head	Phytotoxicity (% mortality)
A. Nemagon granules (10 g.) dusted, in planting hole (mixed with 20g. Gypsum)	14.0
B. " " (20 g.) " " " " " " 40g. "	18.2
C. Nemagon, 75% EC (1 in 25) sprayed, in planting hole (approx. 100 ccs)	35.6
D. " " (1 in 50) " " " " " " "	24.7
E. None (Control)	18.7
Sign. Difference	4.96
Coeff. Var. (% G.M.)	1.44

Path. 8.

BANANA VARIETAL RESISTANCE TO RADOPHOLUS SIMILIS

6 x 6 Latin Sq. 6 Treatments. 2 sub-plots: I. Planted on site of old Lacatan mat.
II. Planted in between old mat sites.

Main plots — 8 plants
Dates examined: A. 3/3/58. Half of each plot — all roots
B. 24/7/58. Remaining half of each plot — sector of root system.

Variety		No. Roots A.	No. Roots B.	Ht. A.	Circumference of corm.	DISEASE INDEX NO. 13/3/58 I	13/3/58 II	13/3/58 Mean	24/7/58 I	24/7/58 II	24/7/58 Mean	Position I	Position II	Sign. Diff.
Triploid	(Lacatan	26	53	29.4	14.2	23.0	19.0	21.0	48.3	44.6	46.5			
	(Robusta	47	57	44.3	19.9	36.0	24.0	30.0	59.2	49.8	54.5	A. 27.0	11.4	6.0
	(Gros Michel	47	58	38.9	16.3	27.0	10.0	18.5	36.7	34.3	35.5	B. 42.1	34.0	3.3
Tetra-ploid.	(A.	46	50	38.3	15.4	21.0	3.2	12.5	36.3	22.0	29.2			
	(B.	39	50	30.4	14.5	21.0	3.5	12.3	33.5	24.8	29.2			
	(C.	51	62	35.5	16.2	34.0	8.8	21.4	38.5	34.0	36.3			
Sign. Diff.	P,0.05	–	–	–	2.5			5.6			5.7			
	P,0.01	–	–	–	3.4			7.6			7.7			
Coeff. Var. (% G.M.)		–	–	–	12.8			24.1			12.2			

SPECKLE (FRUIT SPOT)

Path. 9.

Nitrogenous fertilizer experiment

4 Randomized Blocks. 6 Treatments. 2 Sub-treatments (a) Single, (b) Double application.
Field Planted 27/10/56.

Fertilizer Treatments (Single application).

A. Sulphate Ammonia — 4 ozs.
B. Urea — 2 ozs.
C. Sodium nitrate — 4 ozs.
D. Sporumix A. — 4 ozs.
E. Sporumix B. — 4 ozs.
F. None (Control)

Applied every three months.

Treatments	Height Plant	Height Ratoon	Girth Plant	Girth Ratoon	Weeks to Shooting	Plants Weeks Shooting to reaping	Grade Plants	Grade 1st Ratoon	Bunch Wt. Plants	Speckle Index No. (a)	Speckle Index No. (b)
A. Sulphate Ammonia	109	139	7.1	7.6	33.7	13.1	7.9	8.6	38.6	1.8	0.9
B. Urea	109	143	7.0	7.9	32.9	12.6	8.0	8.9	41.6	1.5	0.9
C. Sodium Nitrate	109	142	7.1	8.1	34.4	12.5	8.0	9.1	41.1	1.8	1.1
D. Sporumix A	103	136	6.7	8.0	36.7	12.7	7.7	8.8	34.6	1.8	1.2
E. Sporumix B	105	134	6.8	7.7	35.7	12.2	7.8	8.9	36.6	2.2	0.8
F. None (Control)	104	137	6.7	7.7	35.7	12.2	7.7	8.7	36.6	1.3	1.2
Sign. Diff. P,0.05	4	—	0.3	—	1.9	0.8	—	—	5.1	—	—
Coeff. Var. (% G.M.)	3.9	—	2.7	—	15.3	4.2	—	—	8.1	—	—

Asst. Path. 1. **ANTHRACNOSE**

Frequency of **G. musarum** lesions on Lacatan Bananas
(60 bunches)

Position of Hand	Outer Fingers		Inner Fingers	
	No. Examined	% with lesions	No. Examined	% with lesions
Tip-end	455	33	320	9
5th	495	34	377	12
Butt-end	612	27	482	11
Mean %		31.3		10.6

Asst. Path. 2. **SANTA MARTA STEM END ROT**

Finger-stalk Rot and Discharge Injury observed at Port

Consignment	No. Bunches Examined	No. Hands Examined	Hands with Established S.M.S.E.R.		Hands with 1 or more recently damaged finger-stalks.	
			No.	%	No.	%
S.S. "Manistee" 24:11:58	116	824	—	—	97	11.7
S.S. "Sulaco" 8:12:58	72	524	341	65	77	14.7

Asst. Path. 3. **SANTA MARTA STEM END ROT**

Amount of S.M.S.E.R. and Finger-stalk Injury Before and After Despatch to Ripening Rooms
(S.S. "Chicanoa", 21:12:58)

No. Bunches Examined	No. Fingers Examined	Quayside Assessment		Ripening Room Assessment	
		% Fingers with S.M.S.E.R	% Fingers with new injury	% S.M.S.E.R.	% new injury
19	1886	17.6	1.4	17.6	18.3

STAFF AT 31st DECEMBER, 1958

Director & Plant Pathologist	R. Leach. M.A., A.I.C.T.A.
Crop Physiologist	E. A. Tai, M.Sc., D.I.C.T.A.
Agronomist	V. R. Lumsden, B.A. Dip. Agr. (Cantab.)
Soil Chemist	C. G. Jordine, B.Sc.
Assistant Plant Pathologist	D. S. Meredith, M.A., Ph.D.
Analyst	Mrs. D. E. Boland, B.Sc.
Senior Field Officer	W. G. Chambers
Field Officers	B. G. Coley, H. H. Christie, G. L. McKenzie, N. O. Toyloy, J. A. Morris, L. R. Crombie.
Technical Assistants	J. E. Meikle, S. A. Shim, M. E. Lumsden, T. A. Mair, Miss D. V. Wishart, Miss P. Y. Boyd, Miss J. Thomas, Miss M. P. Toyloy.
Secretary & Librarian	Miss B. McLean
Stenographer/Typists	Miss M. Lopez, Miss L. Toyloy
Handymen to Field Officers	V. Powell, R. Bartley, D. Gray, R. Peynado
Handymen (Head Office)	R. Datadeen, H. Bell.
Laboratory Cleaners	I. Braham, E. Brown

DIAGRAM 1

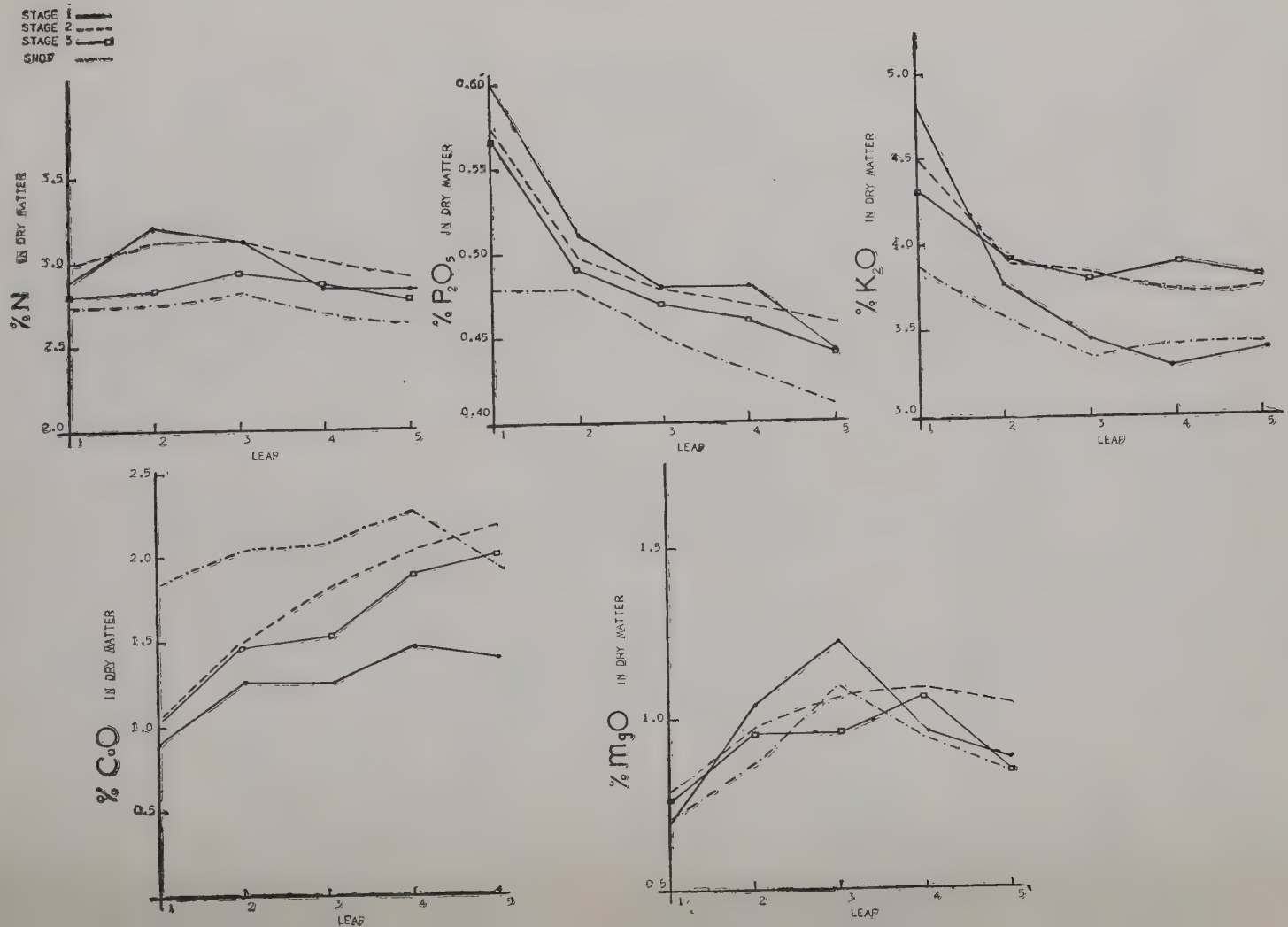

STAGE 1
STAGE 2
STAGE 3
SHOT
% N IN DRY MATTER
% P_2O_5 IN DRY MATTER
% K_2O IN DRY MATTER
% CaO IN DRY MATTER
% MgO IN DRY MATTER
LEAF

DIAGRAM 2

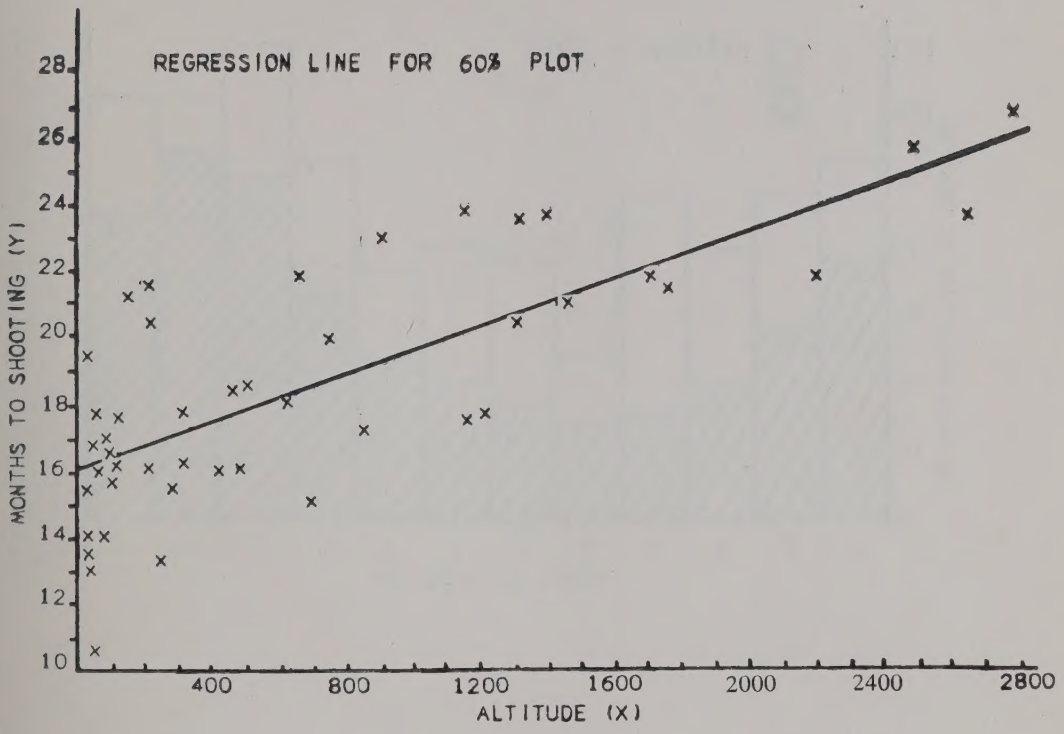
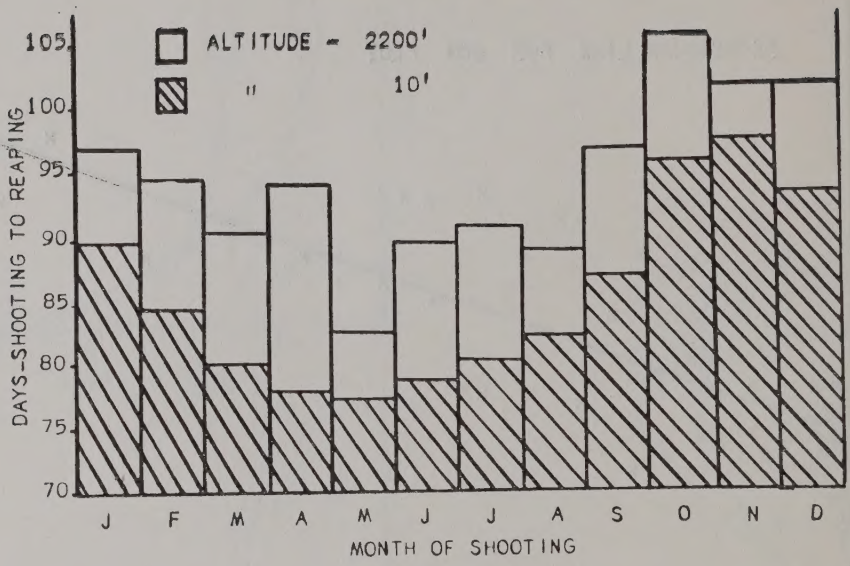

REGRESSION LINE FOR 60% PLOT
MONTHS TO SHOOTING (Y)
28
26
24
22
20
18
16
14
12
10
400
800
1200
1600
2000
2400
2800
ALTITUDE (X)

DIAGRAM 3


ALTITUDE - 2200'
" 10'
DAYS-SHOOTING TO REAPING
105
100
95
90
85
80
75
70
J F M A M J J A S O N D
MONTH OF SHOOTING

Printed by
UNITED PRINTERS LTD.
218 Marcus Garvey Drive
Kingston, Jam., W.I.
4604 — 6/59.